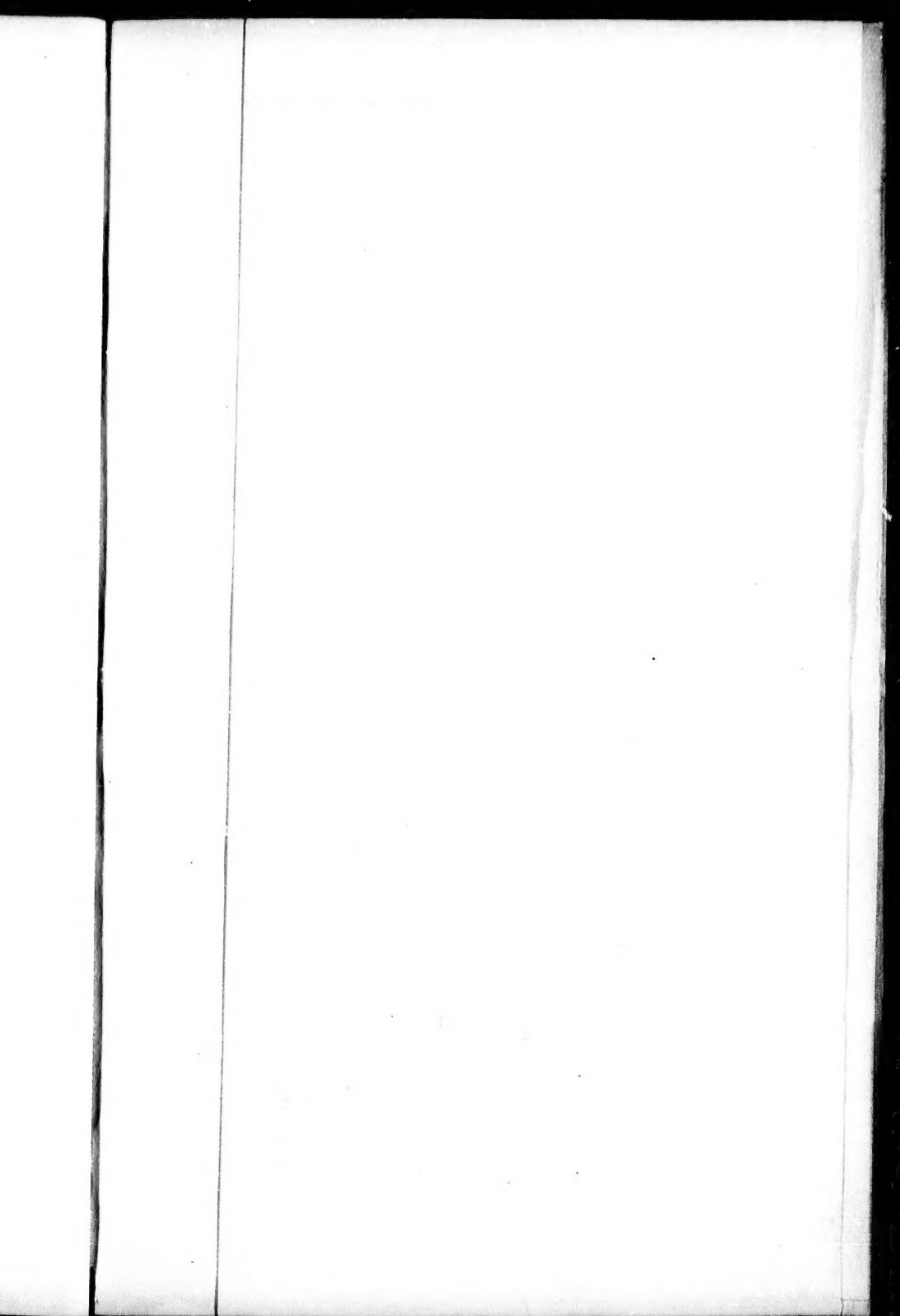
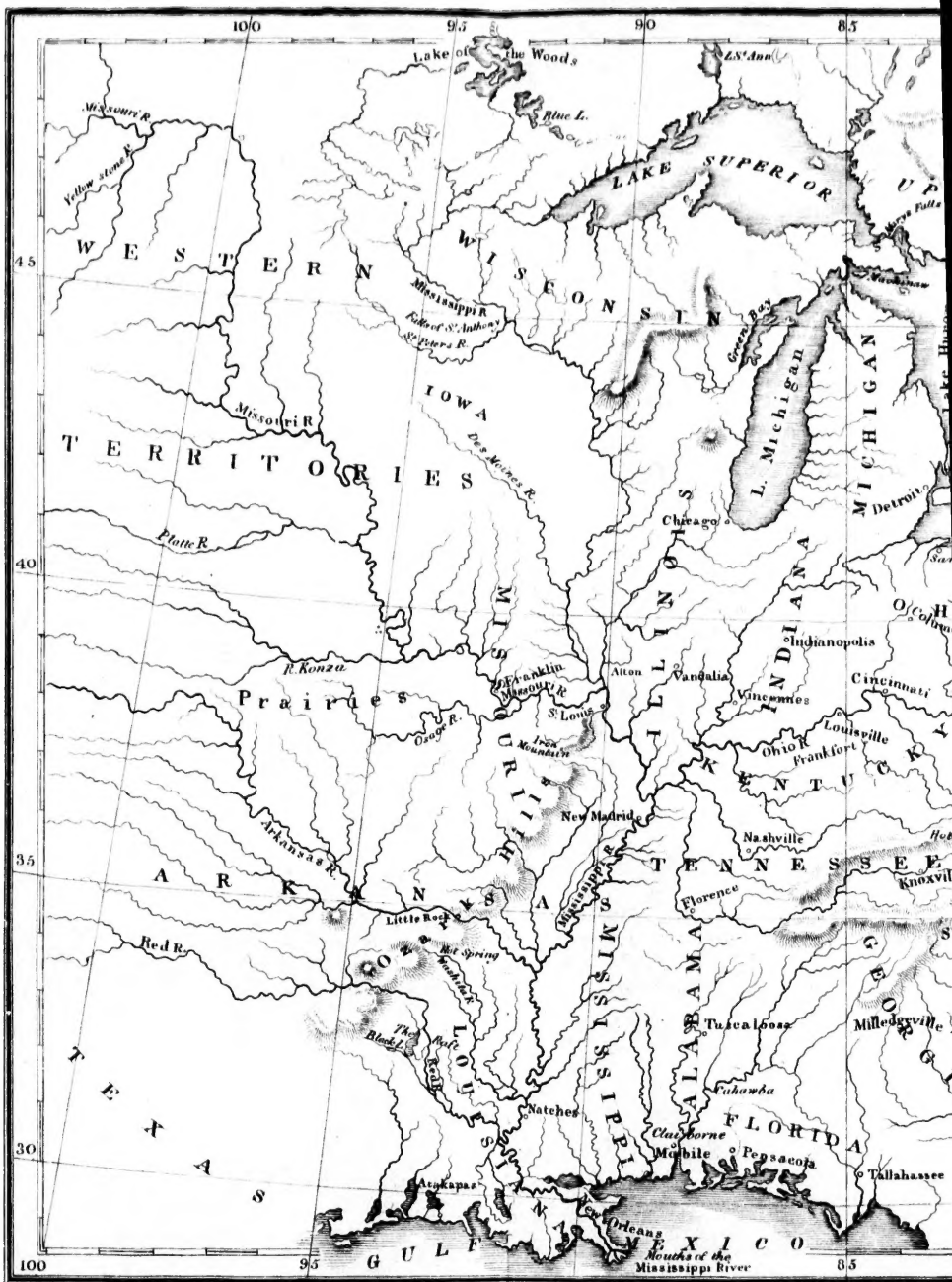










S K E T C H
OF THE
GEOLOGY OF NORTH AMERICA,
BEING THE
SUBSTANCE OF A MEMOIR

READ BEFORE THE ASHMOLEAN SOCIETY NOV. 26, 1838.

BY

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HELD AT PHILADELPHIA,

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OXFORD,
PRINTED BY T. COMBE, PRINTER TO THE UNIVERSITY, FOR
THE ASHMOLEAN SOCIETY.
MDCCCXXXIX.

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TO
THE PRESIDENT AND MEMBERS
OF THE
AMERICAN PHILOSOPHICAL SOCIETY
HELD AT
PHILADELPHIA.

Oxford, August 1, 1839.

GENTLEMEN,

I KNOW not to whom I can more appropriately inscribe the present humble attempt to elucidate the geological structure of that portion of the continent of America from which I have lately returned, than to a Society, in whose prosperity I feel an interest commensurate to the regard I cherish for several of the members that compose it; and which moreover has an additional claim to my sympathy and good wishes, from having conferred upon me the honour of enrolling me amongst the number of its Associates.

Your Society also is one, which, independently of all considerations of a personal nature, demands the consideration of Englishmen, as

the first institution that had sprung up amongst their Transatlantic Brethren, for the express encouragement of science and literature; objects of which you have at no time lost sight, as the names of a Franklin, a Rittenhouse, a Jefferson, and a Du Ponceau, who have successively figured amongst your Presidents, would alone be sufficient to testify.

And it is with renewed pleasure that I am thus led to look back upon a Body, which is associated in my recollections with the good city of Philadelphia—a spot, towards which I had felt favourably disposed, from the history of its first settlement, and the moral qualities of its Founder, even before I had seen them both blazoned forth in the eloquent pages of a living native historian^a; and one too, which when I at length visited it, not only conciliated my regard by the kind attentions I received from many of its principal citizens, but likewise continued to justify in my estimation, its title to the name of the “City of Brotherly Love,” by the munificence of its charitable institutions, the benevolent aim of its prison-discipline, and the general urbanity of its population.

I will also confess, that having experienced the benefit of those ancient collegiate establishments, by the aid of which so many of my own countrymen are enabled to range freely through the domains of science or literature, according as their respective tastes may direct, without being

^a See Bancroft's History of the United States, vol. ii. ch. 16.

drawn aside from either by the "stern realities of life;" I looked with peculiar complacency and hope on the prospects of your city, as the spot recently selected for an Institution, not less munificently endowed, and I trust not less adapted to minister to the same beneficial purposes.

Others indeed, more imbued with utilitarian principles than I profess to be, may grudge the application of the vast wealth of a Girard to the foundation of a single college; but those who regard the endowment in question, as a fund, by the aid of which a body of men may be induced to devote their lives to the advancement, as well as the dissemination of learning, and to pursue knowledge for its own sake alone, contented to regard it as an end, and not merely as the means of arriving at other objects—such persons, I say, will view this munificent benefaction, as one calculated to diffuse a more elevated tone of feeling around it, and to raise the intellectual character of Philadelphia amongst the cities of the Union.

But the greater reason I have for looking up to the Society, to which the present publication is addressed, the more incumbent do I feel it to be, to apologize for its slender merits.

Had indeed my attention, during my stay in your country, been concentrated on matters connected with Geology, or even with Natural History in general, it is possible I might have collected materials better worth laying before

your Body, than those which I now presume to address to you.

But what Englishman could visit for the first time a land like America, without having his attention from time to time drawn aside from the features of inanimate nature ; or without interesting himself in the character and destinies of a race, which in some respects has so much in common with his own, and in others stands in such remarkable contrast to it ?

I therefore present the following Sketch of American Geology, as embodying the result of one only out of many inquiries which divided the time of my residence in your country ; although when I reflect upon the difficulty and invidiousness of the task I should impose upon myself, were I to attempt to delineate the moral and political condition of your Republic, I feel indisposed to trust myself in print beyond the field embraced by the present Report.

It might not indeed have been difficult for me, to have filled the number of pages requisite for a popular work of travels, by a picture of the peculiarities that lie upon the surface of American society, but regarding the publications of this class which have issued from the British press as disproportionately great already, I felt no inclination to add to their number.

Not, indeed, that I would be understood to join in the outcry, that has been raised in America against the class of writings alluded to. In spite of the exaggerations which they con-

tain, and the prejudices which they undoubtedly display, it is impossible not to perceive, that they have executed for your countrymen an useful, though, I fear, rather a thankless office—one, that in other parts of the civilized world is performed by the popular novelist, or satirist, that the nation itself is sure to supply, but which in yours, like many other tasks which the omnipotence of public opinion obliges native Americans to decline^b, remains open for competitors from another country.

Whilst, however, I give all due credit to the Trollopes, the Hamiltons, and the Maryatts, for having supplied a deficiency, which every one must perceive to exist in your literature, (for your own popular delineators of national manners touch too tenderly upon the foibles and defects which they hint at, to answer the desired end,) I cannot but regret at the same time, that a state of society, at once so novel in its character, so pregnant with important consequences from its influence on other nations, and so

^b Dr. Channing, though not to be placed with either of the above-mentioned classes of writers, belonging, as he does, to a much higher grade of literature than either, ought nevertheless to be exempted from the remark in my text; for though he evinces in his works a just pride in his title as an American citizen, and disdains to measure the national character by a purely European standard, yet he has on no occasion been withheld from frankly and fearlessly *telling his countrymen the truth*, even on subjects on which they evince the greatest sensitiveness.

See his Letter to Mr. Clay on the Annexation of Texas, a pamphlet not less distinguished for beauty of composition, than for the enlarged and independent views which it develops.

peculiarly interesting to Englishmen, from the affinity subsisting between the people which are experiencing its operation, and their own, should not have been commented upon by British writers in a more philosophical, and, if I may so express myself, a more *catholic* spirit. The common error, indeed, upon which English writers, of whatever politics, have proceeded in treating of your country, appears to be that of regarding the peculiar form of government that happens to prevail amongst you, as if it were competent to furnish a key to all the peculiarities which characterise your race.

Hence those who have brought with them from Europe their aristocratical predilections, seize with avidity on every disadvantageous trait in the American character, as illustrative of the evils of democratic governments; whilst others, in their zeal for republicanism, instead of looking abroad for the cause of such defects as they espy, and searching for them in the circumstances affecting your moral and physical condition in which government has no share, are too apt to set them down at once, as resulting from a remnant of the old leaven of feudality, which, according to them, still lingers in your constitution, and interferes with the proper working of its popular elements.

But there is more true philosophy in the well-known lines of Goldsmith,

How small, of all that human hearts endure,
That part, which laws or kings can cause or cure !

for it is certain, that whatever may be the form of government which a country possesses, its spirit is in a great degree determined by the state of society, which causes antecedent to its existence, or at least manifestly independent of its influence, have conspired to bring about.

Thus, nothing is more striking than the difference between the state of manners in the southern, northern, and western portions of the Union, enjoying, as they do, the same democratic institutions; nor is it conceivable, that if the monarchical form of government had maintained its ground to the present day in the newly-peopled states, its existence would have materially lessened that independence of the lower classes of the higher, which seems to be the necessary consequence of the scanty supply of labourers, and of the security against want, which the vast unpeopled regions of the west afford to the meanest of your citizens.

For my own part, were I called upon to offer an opinion upon the American constitution, I should not hesitate to aver, that no other than a democratic form appears, either to be in harmony with the existing state of society, or to be capable of maintaining its ground in a country so circumstanced; but it would be uncandid were I not to add, that the effects which I considered myself warranted in tracing to the operation of the democratic principle were not calculated in general to prepossess me in its favour, or to re-

concile me to the prospect of its wider dissemination.

Not that I am on this account induced to take a gloomy view of the destinies of your republic: for, in the first place, I believe the unfavourable influences of democracy to be in a great degree counteracted in it by other causes; in the second, I can conceive, that without any change in the letter of the existing constitution, its democratic spirit may itself become softened down by the changes which society will have to undergo; and, in the third place, I feel persuaded, that there is such a fund of practical common sense in the people at large, such a contempt of mere theory, such a general indisposition to sacrifice the palpable interests of the community for the sake of maintaining certain abstract principles, that the same change of circumstances, which should render the present form of government no longer applicable, would reconcile you to such political reforms as might then appear to be required.

But these, and other questions affecting the social condition of your country, are likely to be discussed with more success by those, who, like Monsr. De Tocqueville, belong to a different race, and therefore contemplate the state of society existing in America, as it were, from a distance, and without any feelings of partisanship.

The appropriate province of the British inquirer in America is of a somewhat different nature.

Proceeding upon the assumption, that the feelings, manners, habits, laws, and institutions of the United States are based upon those of the Parent State, he should regard those modifications which have taken place in your country, in any one of the above respects, as worthy to be noticed and recorded, as examples, or as beacons to his own.

If history in general deserves our attentive study, as detailing a series of experiments on human nature which our forefathers have instituted, although without intending it, for our benefit and instruction, how preeminently useful to us must the record of those experiments be, which have been undertaken upon a people so nearly approaching to ourselves, both in point of time and national physiognomy, as that of the United States of America !

Thus it might have prevented many a crude essay in legislation at home, if we had been made acquainted with the bearings and the operation of those laws which have from time to time been enacted in the several parts of the Union, all founded on the common law of England, but moulded nevertheless in various ways to suit the exigencies of the particular community by which they were decreed.

So also in our discussions on the subject of Academical Education, we might have had more certain ground to proceed upon, than any *a priori* reasoning could supply, if we had been made acquainted with the details of the system

pursued at the different American Universities with reference to these debated points.

The originators of the London University, for instance, who contended for the impossibility of combining religious instruction with the indiscriminate admission of sects, might have learnt from the case of the University of Virginia, what success had attended the experiment, previously instituted under the auspices of President Jefferson, to establish a system of education wholly unconnected with any form of religious worship.

And on the other hand, those amongst ourselves who contended for the opposite principle, would have done well to inquire, by reference to the Universities of New England, how far such a plan admitted of realization.

Again, the comparative advantages of an endowed, or an unendowed Church, might have been elucidated, by a careful examination of the state of the several religious Denominations existing in America, or of the same Denominations in different parts of the Union, according as it is supported in the one or other of these ways ^b.

Such inquiries seem to lie midway between those lofty but often barren speculations, with respect to the political institutions of the United

^b It is a mistake to suppose that no form of worship in the United States is endowed, because no one is established. The Episcopal Church at New York affords a striking proof of such being the case.

States, in which one class of travellers have indulged, and the familiar portraiture of men and manners which has served as the favourite theme of another.

But, for my own part, whilst I wanted the inclination to associate myself with the latter, I felt too sensibly my own deficiencies, both as to time and information, to think of aspiring to a place amongst the former.

If however my observations on the American character are likely to lead to no results in which the public are interested, they have at least had the good effect of dispelling from my mind many prejudices, and of enabling me to take a more candid and dispassionate view of my brethren on the other side of the Atlantic, than I could otherwise have arrived at.

My experience indeed has not blinded me to the unfavourable influences upon national manners, which arise from that nearer approach to social and political equality existing amongst you, than any other civilised nation hitherto has attained to; and so far from leading me to lament, with certain political enthusiasts of my own country, that the tendency towards this ideal goal of perfection, which your commonwealth has displayed, has been somewhat checked in its downward course by other causes, it has taught me rather to congratulate myself, that such a state of things must, from the very laws of human nature, be ever partial and incomplete.

Neither has it enabled me to look exactly with the eye of national partiality upon a *free-born American*, who, if we were to believe the hyperbolical language of self-flattery,

uno minor est Jove, dives,

Liber, honoratus, pulcher, rex denique regum—

and (with a proviso, the force of which will be appreciated by a tobacco-loving nation,)

Præcipue sanus, nisi cum pituita molesta est.

But seriously, and in good faith, I am proud to regard the people of the United States, however widely separated from ourselves, in a political, or in a geographical sense, they may be, at least as no unworthy scion of the Anglo-Saxon stock, and thus to be able to contemplate the race to which I belong, not only spreading itself more widely every succeeding year, but maintaining throughout that ascendancy, whether in point of energy of character, or of intelligence, in the New, which I trust it has established for itself in the Old World,—possessing indeed the glorious distinction, which those who have visited either French Canada, the Brazils, or Spanish America, will be equally ready to concede as their due—that of being the only member of the great European family of nations, which has not wofully degenerated by transplantation.

With such a nation, there must after all exist in the breast of every true Briton a greater congeniality of sentiment, and consequently a

more real sympathy, than with any of his continental neighbours; and it will be in all respects a subject for congratulation, if an increasing desire on our part to study the manners, the institutions, or even the natural history of your country, shall continue to create a gradually increasing intercourse between us, and thus lead to a better mutual understanding, and a more liberal construction of each other's peculiarities.

If therefore the present sketch of the Geology of this vast continent should kindle in the mind of any of my English readers a desire, to explore the regions which I have endeavoured to bring before their notice, I may plume myself at least on having contributed somewhat towards this great national object, and on having brought my countrymen into closer and more friendly connexion with the Society, and with the City, to which this Memoir is dedicated.

I beg to subscribe myself,

Gentlemen,

with great respect and esteem,

your obliged and devoted servant,

CHARLES DAUBENY,

Professor of Botany and Chemistry
in the University of Oxford.

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S K E T C H

OF THE

GEOLOGY OF NORTH AMERICA.

BRING THE SUBSTANCE OF A MEMOIR READ BEFORE THE
ARHMOLEAN SOCIETY, Nov. 26, 1838.

THE country, which I propose to bring before your notice on the present occasion, lies betwixt the 30th and 47th parallel of north latitude, and the 71st and 90th of west longitude, a distance as great from north to south, as from St. Petersburg to Naples, and from east to west exceeding that from London to Warsaw.

The space comprehended within these limits does not therefore fall far short of 1000 miles square, and is equal to the greater part of Europe, for it will be found to exceed the dimensions of all the countries put together, which this portion of the globe contains, if Russia and Turkey be excepted.

For traversing so vast a tract I was able to allow myself barely a year, including the time occupied by the voyages to and fro, and even of this short period a considerable portion was consumed in the towns, during the winter season, when the observation of men and manners offered more attractions than the features of external nature.

It will therefore readily be perceived, not only that within the compass of one of these evening meetings it would be impossible to bring before you

more than a mere outline of so vast a subject, but that even supposing your time and mine to have admitted of further details, a sufficient excuse for confining myself to generalities would have existed in the cause already assigned—the shortness of my stay in the country itself.

If I had trusted indeed, in drawing up the present communication, to my own scanty notes alone, I should have found myself unable to impart to the facts laid before you, any thing like unity or connection; but I have largely profited, during my stay in the New World, by my intercourse with many intelligent naturalists, and have, I hope, in many instances, supplied the deficiencies of personal experience, by the aid of the information, so freely and so obligingly tendered me.

But the most abundant source from which I have drawn materials for this sketch, is the assemblage of reports relative to the geology of several portions of the Union, which have been published within the last few years, under the auspices either of the local or the general governments.

Amongst the geologists engaged in these undertakings, I may mention in the first place, our countryman, Mr. Featherstonehaugh*, who is employed by congress in examining the territories, not as yet attached to any particular state, though the property of the confederacy collectively; and who, in obedience to their instructions, has described the district intervening between the Missouri and Red rivers, since incorporated in the new states of Arkansas and Missouri.

* Now, July 1839, appointed by the British government commissioner to survey the boundary line of the disputed territory.

Twelve states of the Union have already followed the example of the Federal government, in publishing geological reports; namely, Maine, Massachusetts, Connecticut, New York, New Jersey, Maryland, Pennsylvania, Virginia, Michigan, Indiana, Delaware, Tennessee, and Ohio; whilst Michigan, Kentucky, and South Carolina have more recently, with the same intent, directed similar surveys to be set on foot in their respective territories.

One cannot but augur the best results to science, from an examination of the geological structure of so vast a tract, conducted on this systematic plan, especially when it is extended, as no doubt it will be, to all parts of British America.

It is possible, indeed, that the utilitarian views which appear in many cases to have prompted these undertakings, will not always be realized to their full extent; but we may be sure, that, like the farmer in *Æsop*, who, though he failed in discovering the treasure he was in quest of, got rich, nevertheless, by fertilizing his land, in the process of turning it up, the nation at large will reap the fruits of the labours it has promoted, in the impulse they will give to scientific inquiry, and the information they will tend to diffuse throughout the community.

Amongst the individuals, to whose oral instructions, as well as to whose published works, I feel myself particularly indebted^b, I may mention two brothers by the name of Rogers, one of whom,

^b To the above list, I am now bound to add the name of my excellent friend professor Silliman, who, by kindly undertaking the trouble of revising this Memoir, has supplied the public with a sort of guarantee, that it is exempt at least from any serious errors.

professor Henry Rogers, has become personally known to many English geologists, during the residence he made in this country not many years ago. Since his return he has been appointed to the chair of geology in the university of Pennsylvania, and in that capacity, after having completed a geological survey of New Jersey, is now engaged upon a similar one of the state in which he resides; his brother professor William Rogers, has an appointment in the neighbouring state of Virginia, being attached to the university founded by the exertions and influence of the late president Jefferson at Charlottesville, and to him we have to look for a geological survey of that state, in which he has been for several years engaged, and of which, indeed, the first fruits have already appeared.

It is fortunate, that the surveys of Pennsylvania and Virginia, countries which, stretching across from the Atlantic to the Ohio, afford a key, as it were, to the structure of the entire continent, are confided to two individuals, so well qualified, from their general attainments, for the task, and so likely, by pursuing their labours in concert, to present a consistent view of the whole region which they describe. Hence I look forwards with confidence to the time when we shall be enabled, through the information thus afforded, to solve the important problem, how far there exists a resemblance between the mineral structure of the old and new continent, and whether an identification can be made out of the rocks found in these remote portions of the globe, to such an extent, as should justify us in applying to formations met with in one hemisphere, names that have been already imposed upon those of the other.

On this question the American geologists seem at present to be much divided.

Thus on the one hand, Mr. Conrad, who has undertaken the palæontological department of the survey of the state of New York, goes even so far as to identify certain of the formations contained in that state with the Ludlow rocks of Murchison, others with his Dudley limestone, a third series with the dye-earth of Shropshire, a fourth with the arenaceous sandstone of Wales, and a fifth with the Llandeilo flags^b.

On the other hand, the professors Rogers have acted upon the impression, that, although such an identification is not to be despaired of, yet it can in no instance be yet viewed as established, and hence, instead of attaching names to the rocks described by them, they have preferred for the present to designate them merely by a series of numbers, dependent on the observed order of their superposition.

There is one circumstance, however, which might lead us to suspect, that the similarity between this portion of the globe and our own is not so great as has been anticipated—I mean, the absence of modern volcanic operations, and even of all indications, over a considerable portion of the country under review, of any such having ever occurred; whence arises probably the more frequent horizontality of the strata, the greater simplicity of structure and continuity of the mountain chains, the more rare appearance of thermal and carbonated springs, and, when the wide extent of surface is taken into account, the unfrequent occurrence of earthquakes.

^b See New York Report, for 1838.

In the above respects, the portion of North America, included within the range of the United States and of the Canadas, partakes more of the character of Russia and Poland, than of Germany, France, and Italy, of which latter countries, the analogues are to be met with in more southern latitudes of the western hemisphere, as in Mexico, Guatemala, and the West Indian archipelago.

This resemblance with the northern parts of Europe seems most complete, when we compare the latter with that portion of the American continent, which is included between the great lakes and the coast of Labrador, so far at least as that tract has been hitherto explored; for there, although primary or crystalline rocks prevail, there seems, nevertheless, to be an uniform dead level, rarely relieved by any abrupt elevations, whereas, south and east of the lakes, this uniformity is broken in upon by the chain of the Alleghany mountains, which stretch in one continuous line from north-east to south-west.

I will consider, then, in the first place, the indications which this continent affords of the action of water, and afterwards proceed to the changes that appear to have been wrought in it by the operation of fire.

There is probably no portion of the globe, where the effects of the daily and continuous action of running water may be better studied than in the great valley of the Mississippi, through which, that mighty river, with its numerous tributaries, is constantly carrying down such masses of mud and drift timber, as will, in the course of years, convert a large portion of the Gulf of Mexico into a continuation of

that vast alluvial tract which it has already formed, and may, perhaps, if time enough be allowed it, connect at last the island of Cuba with the continent of North America.

These processes, however, have been so fully discussed by Mr. Lyell, that I shall abstain from any further mention of them, except to remark, that amongst the cases of drift timber, which he enumerates as collected in the beds of these rivers, he has omitted the most remarkable one, I mean the *raft*, which for seventy miles in extent had blocked up the course of the Red river^c, until the last

^c The following is the description given by Mr. Flint of this obstruction to the navigation of the Red river, (vol. i. p. 539.) "Through the greater amount of its course the Red river winds through immense prairies of a red soil covered with grass, and vines that bear delicious grapes. On its banks is the favourite range of the buffalo, and the other game peculiar to the immense western ocean of prairies. About thirty leagues above Natchitoches commences the raft, which is nothing more than an immense swampy expansion of the alluvia of the river, to the width of 20 or 30 miles. The river spreading here into a vast number of channels, frequently shallow of course, has been for ages clogging with a compact mass of timber, and fallen trees wafted from the upper regions. Between these masses the river has a channel, sometimes lost in a lake, and found by following the outlet of that lake back to the parent channel. There is no stage of the water, in which a keel boat, with an experienced pilot, may not make its way through the raft.

"The river is blocked up by this immense mass of timber for a length in its meanders of between 60 and 70 miles. There are places, where the water can be seen in motion under the logs. In other places, the whole width of the river may be crossed on horse-back, and boats only make their way, in passing these places, by following the inlet of a lake, and coasting it to its outlet, and thus finding the channel again. Weeds, flowers, shrubs, and small willows have taken root upon the surface of this timber, and flourish above the waters. But in all these places the courses of

year, when it was so far removed by the exertions and skill of captain Shrive with his snag boat, as to render the navigation practicable, and thus to extend the water communications of that portion of the United States nearly 1000 miles further westward than before, in the direction of the Rocky mountains and the frontiers of Mexico.

Of the more violent action of water we observe the effects, in the loose erratic blocks so extensively distributed over the surface of both the Canadas, of the State of New York, and of various parts of New England.

Those of the Canadas are noticed by my friend Major Bonnycastle, in the first volume of the Transactions of the Literary and Historical Society of Quebec, page 62.

The boulders of the Jura and of Germany, he remarks, are of small import and of limited extent, when compared to those of Canada. I have travelled by land or along the shores from Prescott to Lake Erie, and everywhere these singular strangers present themselves to view, thickly spread over rocks and soils, to which they might, in a few instances, be ascribed. The river, its outline, and its bends, are distinctly marked by a margin of forest trees, which grow here on the banks, in the same manner as they do where the channel is open.

"It is an impediment of incalculable injury to the navigation of this noble river, and the immense extent of fine country above it. There is probably no part of the United States where the unoccupied lands have higher claims, from soil, climate, intermixture of prairies, and timbered lands, and every inducement to population, than the country between the raft and Kiamesia.

"The river above the raft becomes broad, deep, and navigable for steam boats, in moderate stages of the water, 1000 miles towards the mountains."

stances, be supposed to have originally belonged. I have observed them equally strewing the shores of the Lakes and of the St. Lawrence, and covering the mountains and the hills, and that too, as in Pelham township, at a very considerable elevation. Here (at Kingston) they line the low limestone shores of the Lake, and consist of hard schists, of granites, of gneiss, of quartz, of black basaltic looking masses, and of nearly pure felspar.

The granites on the higher plateaus of the limestone of Fontenac are so numerous and varied, that I am confident in a few hours above a hundred specimens of different kinds might be procured, but there are no data, either from their form or their position, on which a theory of a plausible nature as to the route they have travelled could be drawn. The diluvian dressings, as they are rather affectedly termed, have been so variously rolled about, that the side on which these boulders have received the most severe chastisement is undoubtedly not recognizable. I have fancied, that I could perceive there was a kind of regularity in their general position, but I cannot as yet speak with certainty. I conjecture that they are in nearly parallel lines on the flat tables which this part of the country affords, but I shall not hazard a statement until I have opportunity to inquire more largely. Altogether the subject of the Canadian boulders appears one of the deepest interest.

Those of the State of New York in Long Island and the adjacent parts, are described in the Geological Survey for 1837 (p. 87, 88), and for 1838, p. 133.

They vary from the size of a pebble to masses weighing several hundred tons, are found inter-

stratified with deposits of sand, clay, and gravel, and when first disinterred exhibit scratches on one or both of their sides. These characters, however, correspond with that of the rocks in their immediate vicinity, and are always in a southerly line from their beds, so as to indicate the direction of the force by which they were detached. Mr. Mather considers the theory of transport by ice, as corresponding more closely with the facts, than any other that has been proposed. The occurrence of these boulders and blocks, as it were in nests on the south side of the hills, and generally on elevated grounds, he conceives strongly favours this view of the subject.

The erratic blocks found in New England are particularly dwelt upon by professor Hitchcock, in his Report on the Geology of the State of Massachusetts, p. 152.

The whole country, he says, east of a line drawn from Providence to Boston, except the summits of a few of the highest mountains, and some alluvial valleys, is covered with diluvial blocks and gravel.

But from Boston to the extremity of Cape Ann, embracing a considerable proportion of Essex county, the amount of boulders is prodigious, and some of them are not less than thirty or forty feet in diameter; and yet so powerful was the diluvial current, that these must have been removed from their original position, and many of them now occupy the summits of the highest hills in that region.

Professor Hitchcock also alludes to other phenomena indicative of the same event, which are presented in the country now under review.

One of these is the gorge, between mount Tom

and mount Holyoke, in the valley of the Connecticut near Northampton, Massachusetts, through which the river now finds its way—a gorge, which could not have been cut by the action of the stream, since the latter would have flowed through that part of the valley which lies west of the Greenstone ridge now severed asunder, following the course taken by the Farmington Canal, where no such impediment would have been presented. For it appears by the surveys taken of that canal, that in no place is the valley more than 134 feet above the present level of the river at Northampton, whereas the ridge through which it passes is from 800 to 1000 feet high.

Another circumstance which seems to point towards the same conclusion, is the existence of grooves and scratches upon the surfaces of the rocks, even on the summits of the highest hills.

At the top of mount Holyoke, at an elevation of 900 feet above the sea, I saw these distinctly marked upon the face of the greenstone or trap rock, which caps the hill.

These markings were from north to south, and thus coincided in direction with certain slight valleys seen near the same spot at an equal elevation, the direction of which is not conformable with the bend of the mountain itself, being from north to south.

Hitchcock adduces numerous examples of the same phenomena in his Report on the state of Massachusetts, and has likewise alluded to the same in a Memoir on the Geology of Portland in the State of Maine.

“Whoever,” says he, “is in doubt, whether there are any marks of diluvial action in the vicinity of that city, let him stand upon one of these elevated

spots, and account, if he can, for that accumulation of rolled masses under his feet in any other way than by a strong current from the north." After speaking of the diluvial grooves and scratches on the rocks around and within Portland, which he thinks cannot be confounded with those resulting from the unequal hardness of the successive layers of slate, he goes on to say, that Dr. C. T. Jackson of Boston, and Mr. Frederic Alger, in their Memoir on the Geology of Nova Scotia, have rendered a similar testimony with respect to the diluvial phenomena of that country. "Thus," says professor Hitchcock, "we have an almost unbroken series of observations on this subject, from the extremity of Nova Scotia to the western side of our great lakes, a distance of from 1200 to 1500 miles—and with a few local exceptions perhaps, there is decisive evidence of a comparatively recent and powerful rush of waters from the north and northwest."

Thus far professor Hitchcock, who, in common with the majority of American geologists, adopts the language and the theoretical views of professor Buckland; but I perceive from a late number of Silliman's Journal, that attempts have been made to interpret such phenomena in accordance with the principles advocated by Mr. Lyell.

Mr. Hayes of Buffalo, in a Memoir on the Geology of Western New York State, endeavours to shew, that the mere action of the waves and tides upon the rocks, after they became elevated above the surface of the ocean, would bring about all the effects hitherto attributed to the operation of running water. And it may be granted, that the mechanical aggregates so universally distributed amongst formations

of every age may be thus accounted for; but I do not see, how the transportation of boulders to so great a distance from their parent rock can admit of this simple mode of explanation. In adopting it, the author seems to have overlooked the fact, that the force of submarine currents extends but a little way beneath the surface of the ocean, and that even the gulf stream could have no power to move a block of stone along the bed of the sea underneath it, so soon as it was once safely deposited at its bottom.

Accordingly, the geologists in our own country, who reject the notion of diluvial currents, seem in general disposed to call in the aid of other machinery for the transportation of such masses, and Mr. Lyell believes, that their distribution may be accounted for, by supposing them to have been carried by ice, at a time when the lands over which they lie scattered were submerged beneath the sea.

It is probable, that each person will incline in favour of one or other of these hypotheses, according to the degree to which he is disposed to carry his assent to the general principles of Mr. Lyell's theory.

Those who believe, that all the other revolutions of the earth's crust, which geology has revealed to us, may have been brought about in a slow and gradual manner, will of course feel reluctant to resort to a violent and transient cause for the purpose of explaining this one solitary phenomenon; but others, who, though yielding assent to the doctrine, that the laws of nature have ever continued unchanged, conceive nevertheless, that sudden and violent, as well as gentle and gradual operations, make a part of her present system, will probably regard the transport of erratic blocks, as a consequence of one or more of those mighty inundations,

which would have been caused by the sudden elevation of an extensive tract, or by any change in the distribution of land and sea, which should have been brought about within a short period of time.

The term, *diluvial action*, applied to this supposed series of operations, though it may at one time have assisted in giving currency to these views in the world at large, seems of late to have excited a prejudice against them amongst geologists; it has led to an impression, that the theory alluded to must either be reconciled in all respects to the conditions of the Noachian deluge, or must be abandoned altogether; whereas it is quite possible, on the one hand to admit, on the authority of the sacred records, confirmed by the traditions of pagan nations, the reality of the event in question, without attributing to it the phenomena above alluded to; and on the other hand, to maintain, on grounds purely geological, that large masses of water have from time to time swept over our continents, without supposing them to have acted simultaneously upon the entire surface of the globe, or pretending to identify any one of them with the deluge recorded by Moses.

With respect to the changes brought about on the surface of the American continent by other agencies than those of water, changes more generally referred to the elevatory movements caused by subterranean heat, I may mention as the most prominent event of that character that has occurred within the limits of the continent under our present consideration, the uplifting of the Alleghany mountains, with which chain are associated the few thermal springs this country affords, the relation of which to the rocks themselves will however be

better understood, after I have stated some particulars regarding the distribution of the mountains throughout the continent in general.

It appears then, that a range of unstratified primary rocks extends from the State of Alabama through North Carolina and Virginia, constituting what is there called the Blue Ridge, which itself forms the eastern boundary of the mountain tract, comprehended by geographers under the general denomination of the Alleghany Chain.

But the primary rocks are by no means confined to the high country which constitutes the Blue Ridge—they extend eastward nearly to the shores of the Atlantic, and are only concealed, as we approach the eastern coast, by the tertiary or alluvial deposits there superimposed.

In the tract occupied by these unstratified rocks, between the Blue Ridge and the low alluvial district bordering on the Atlantic, is the gold region of the United States. The ore, which is represented as being abundant, especially in the states of N. Carolina, Georgia, and Virginia, exists in veins of quartz, penetrating talcose and chloritic slates, accompanied with iron pyrites. These veins are not regarded by professor Rogers as cotemporaneous, but as resulting from igneous injection, being very irregular in their direction and forms, contracting and expanding suddenly, and producing various changes on the contiguous rocks. Professor Silliman, however, regards the gold ore in Virginia^e and probably in North Carolina, as occurring in beds or layers cotemporaneous with the including rock, and running in the same direction.

^e Professor Silliman's personal examination of the gold region was confined to Virginia.

Near Richmond in Virginia, a bituminous coal formation is found in a basin resting in the gneiss. The coal occurs in considerable quantities, and is worked extensively.

From the statement already given with regard to the range of the unstratified rocks east of the Blue Ridge, we shall not be surprised to meet with gneiss at Philadelphia and near New York, nor at finding, that as the continent extends itself more to the east, in the states of Connecticut and Massachusetts, a greater extension is given to the same class of formations, which, excepting in a few valleys, where the fundamental rock has been denuded to a depth sufficient to admit of the deposition of other strata within its hollows, seems for the most part to predominate.

In New Jersey, the primary ridge traverses the Delaware river at Trenton, and extends from thence to Staten Island, near New York, forming in the above-mentioned State, either a wide zone of many nearly parallel ridges, with steep sides, and a very undulating outline, or else low mountain ranges of moderate elevation, which rarely exceed 600 feet. Granite occurs at Staten Island, and is accompanied with a range of serpentine rocks which extends from New Brighton to a little west of Richmond, a distance of eight miles, and from thence is prolonged to Hoboken opposite New York, where it forms the repository of various interesting minerals, such as nemalite, native hydrat and carbonat of magnesia, marmolite, &c.

The western boundary of this primary chain in the state of New York runs nearly parallel with the general course of the Hudson river, which it crosses between Peekskill and Newburgh, and the beautiful

mountain scenery, which we enjoy during the voyage by steam from New York to Albany, is in great measure caused by the abrupt and lofty escarpments produced and displayed by this magnificent stream, during its tortuous course through the midst of these ancient rocks, from the Highlands about West-point to the Catskill mountains.

In the southern states the primary chain appears to be covered on its eastern side by no rocks more ancient than the tertiary, but in New York State, and in the portions of New England which it traverses, others belonging to the transition or the Silurian system rest upon its flanks.

Thus we find a range of hills consisting of blue limestone with organic remains, designated by prof. Dewey as transition, extending from a few miles east of lake Champlain, by Bennington in Vermont, to New Lebanon and the Catskill mountains in the state of New York; and on the eastern boundary of the primary chain near Boston, a sandstone and conglomerate rock, which Hitchcock has denominated greywacke, intervenes between it and the sea. This rock is the repository of the anthracite coal, of Rhode Island, and of Mansfield in Massachusetts, though there is stated to be this difference between the mode of its deposition and that of the more modern coal formations, that it does not, in the latter named locality at least, lie in a basin dipping in all directions towards a common centre, but alternates with the greywacke, being inclined in the same uniform direction as the beds of the latter rock are found to be.

Of a much later date than the above is the sandstone rock, which may be traced along the bed of

the Connecticut river from Middletown near its embouchure in Long Island Sound, where primary slates appear, as high as Greenfield and Miller's Falls near the southern boundary of Vermont, north of which line this stream again passes among primary rocks, of the same description as before.

Thus the sandstone alluded to appears to form the substratum throughout the whole of the delightful valley of Connecticut, not more celebrated for the pleasing features of its scenery, than for the general comfort, thriftiness, and respectability of its rural population. In its general style of cultivation, in the absence of those extensive forests so common elsewhere in the United States, and in the appearance which the trees present, from being dotted about in groups and patches, instead of collected into large masses, the valley reminded me of some of the better parts of England; whilst the profusion of glistening white paint bestowed on the exterior of their wooden dwellings, and in general the studious neatness and almost quaker-like primness displayed in their domestic arrangements, more resembled what we may see in Holland.

But in what other part of the world shall we have occasion to witness, not merely that entire absence of squalid poverty, but in such perfection that "*aurea mediocritas*," which it needs no republican predilections to contemplate with satisfaction ^f!

It is indeed a condition of society, which no system of government could create, but which is the

^f The writings of Miss Sedgwick, whose graphic delineations of domestic manners sometimes remind us of our own Miss Edgeworth, may be referred to, as affording a pleasing picture of the state of society in this favoured portion of the Union.

happy and spontaneous result of a combination of circumstances rarely found to concur—the union of frugal and moral habits, with an universal diffusion of education—few opportunities of amassing wealth, and yet sufficient inducements existing for steady industry—a spirit of independence, manifesting itself indeed too often in a repulsive coldness of manner, but not unaccompanied with a due respect for public opinion—all these elements of prosperity secured to the inhabitants for a long period of time, by the ready outlet afforded to any redundant population; and, what is of more importance still, by the tendency in the body politic to throw off instantly its *peccant humours*, owing to the temptations held out for its more turbulent and restless members to emigrate into other lands.

These are amongst the circumstances, which render the condition of the inhabitants of this favoured valley so enviable, and which place them at an equal distance from the exuberant wealth and lavish display of a commercial metropolis, as they are from the rudeness and the destitution, which are the inevitable concomitants of every newly formed community.

Professor Hitchcock regards the greater part, if not the whole, of the rock which forms the substratum in this valley, as equivalent to our new red sandstone, though, if this be the case, it is remarkable, that whilst salt is so abundant in the older sandstone and other deep seated rocks of North America, it does not occur in this, which we regard in Europe its most appropriate position. §

§ Professor Silliman informs me that in the Rocky mountains salt is found regularly stratified with the red marl and sandstones, probably the equivalent of the English and Polish formations. “I had the fact” (he says) “from a very intelligent missionary who

A vertebrated animal, probably a saurian, ichthyolites belonging to the genus *palæothrissum*, and vegetable impressions, are met with in it, and some of its beds are said to resemble those of the copper slate of Thuringia: its dip is to the east, its beds being deposited in a hollow existing in the mica slate, gneiss, and granite. It appears to have been deposited since the primary rocks obtained their present position, having undergone no elevatory movement itself, but having been deposited tranquilly in the midst of these older formations, the irregularities existing in it being the effect of subsequent denudation.

The discovery made by professor Hitchcock of birds' tracks on the surface of this sandstone is very remarkable, as it traces back the existence of this class of animals to a period long antecedent to that, at which the earliest vestige of their bones has as yet been discovered.

As these have been both described and figured in professor Buckland's well-known *Bridgewater Treatise*, I will only remark, that having myself visited one of the spots where these tracks have been recognised—a shelving ridge of rock in the bed of the Connecticut river—and compared the impressions seen on the surface of the stone with the more perfect ones selected by the professor for his own museum at Amherst, I went away, fully impressed with the belief, that they could have been produced in no other way, than by the treading of birds of various sizes upon a soft and plastic material.

saw the salt in places and for a great extent; his name is Parker (rev. Samuel, A. M. of Ithaca, New York). He has published a very good account of his travels."

Many of them indeed were obscure, and no one specimen perhaps sufficiently distinct, to establish by itself the fact in question—a comparison of them one with another, a measurement of the distances between them, and an examination of many other little circumstances, which appeared to dovetail one into the other, were required for full conviction.

The tracks were of various sizes, the largest being not less than sixteen inches from one extremity to the other, being broader as well as longer than the footsteps of the ostrich, our largest living bird.

There was generally a spur behind the heel, extending out a considerable distance. In one instance there were markings, resembling the corrugations of the skin connecting the talons, and seeming to prove that the animal was web-footed.

In some cases the impression made in the sandstone was oblique, as if the animal had slid in treading on soft mud.

There were likewise other impressions of footsteps, that represented four toes directed forwards, instead of three, as was the case commonly, so as to lead to a doubt as to the kind of animal by which they were occasioned. Sometimes the steps were twisted alternately to the right and left, and in a few cases we could make out several acute talons appended to the extremities of the toes.

It is curious, as prof. Hitchcock observes, that many of the surfaces upon which these impressions appear are highly inclined, an additional proof, that the sandstone strata had been shifted from their original position, since they first became consolidated.

But the circumstance, perhaps, which most deserves to be insisted on, as establishing a distinction, between the rocks situated in the midst or on the eastern flank of the primary range, and the series hereafter to be described which lies to the west of that chain, is the existence of dykes, or intrusive masses of trap, in all portions more or less of New England.

These are particularly abundant in the valley of the Connecticut, testifying to the fact, that subsequently to the elevation of the Alleghany chain and of the Silurian system of rocks, as well as during the period of the deposition of the latter, igneous operations in this portion of the present continent have been frequent.

Professor Silliman pointed out to me several of these dykes intruding themselves through the sandstone near Newhaven, and professor Hitchcock has traced the greenstone from this place to Northampton in a line, which, though frequently interrupted by gorges and defiles produced by subsequent denudation, seems nevertheless to have been at one time continuous. Here, in the immediate vicinity of the spot at which the bird-tracks already described are to be seen, the greenstone assumes a considerable development, putting on the appearance of stratification, and being interposed between the sandstone, in wedge-shaped masses inclined at an angle of 50° . or even 60° . Thus at Mount Holyoke it seems to lie betwixt two beds of sandstone, the upper of which is seen at the level of the river, a little above which the greenstone crops out from beneath it, and thus continues to the summit of the mountain. At the back of the hill, however, another bed of

sandstone appears, rising from under the trap, so that the greenstone seems to be interposed between the two.

The latter exhibits a distinctly columnar arrangement on the face of the hill, and, owing to the disintegration it has undergone, the upper rows of pillars stand out beyond the lower ones, in such a manner, as to form a tessellated roof over the head of the observer, as he skirts the side of the cliff.

On the edge of the river below Mount Holyoke, a second bed of greenstone occurs, still more distinctly columnar, and this, projecting into the stream by which it is covered when the water is high, exhibits a miniature representation of the Giant's Causeway, which the professor proposes calling "Titan's Pier."

Thus there appears at this spot to be an alternation of two beds of greenstone with the same number of beds of sandstone, but it is probable that the appearance is illusory, and that the trap has in reality been protruded through the sandstone, as dykes manifestly are. Amongst the primary and "transition" rocks round about Boston, greenstone occurs in both these forms; it here alternates with greywacke, passes into syenite, and traverses these and other rocks as distinct dykes. The latter are well displayed near Cambridge, and on the coast about Nahant in the vicinity of Boston.

It appears from Dr. Charles T. Jackson's account of the geology of Maine, that trap dykes are even more abundant along the coast, intersecting the primary rocks, the limestone, and sandstone, in all directions.

But it is in Nova Scotia, along the coast of the

Bay of Fundy, that the trap formation appears to attain its greatest development.

For the particulars I must refer to Jackson's and Alger's interesting work on the geology of that country, merely observing, that it is here associated with a sandstone, rich in salt and gypsum, and incumbent upon coal.

As this is probably the most northern point in the new continent in which this latter substance has been found in any quantity, it is interesting to remark, that the vegetable impressions it contains are of a tropical character.

In order to complete this brief sketch of the rocks that lie to the eastward of the Blue Ridge, I ought to mention those described by professor H. Rogers in his Report on the Geological Survey of New Jersey.

Omitting for the present all notice of those on the north-west of the Blue Ridge, I shall merely allude to a series of rocks which rests unconformably on the south-eastern flank of these mountains, dipping to the north-east, and therefore appearing to be deposited at some period subsequent to the elevation of the chain. The rock which comes most closely into contact with the primary, is a coarse breccia, which seems to extend to the Potomac river in Maryland, where it has been quarried for ornamental purposes, under the name of the Potomac marble, being the material, of which the columns of the house of representatives at Washington has been constructed. Above this is a succession of shales and sandstones, consisting for the most part of pebbles, and grains of the same materials, as those composing the primary strata upon which they may be presumed to rest.

These strata are intersected by dykes of trap, which produce remarkable changes in them, giving rise to crystals of epidote, tourmaline, and other minerals, hardly ever found, except either in primary or volcanic formations.

The trap seems to have overspread the sandstone, forming a continuous bed resting upon it.

The nature of the minerals themselves appears to be determined by the chemical composition of the imbedding rock; thus epidote and idocrase are connected with the shales which contain a small portion of limestone, whilst tourmaline occurs in a material which evidently once was sandstone.

All the circumstances I have mentioned tend to the conclusion, that this sandstone formation is of the same age as, if it be not an actual continuation of, that already described as occupying the valley of the Connecticut.

Intervening between this rock and the sea, occur certain arenaceous beds, with fossils answering to those of the green-sand of England, and others corresponding in date with the Pliocene rocks of Lyell.

These, however, I pass over, as they have been lately fully brought before the scientific public, in a work so easily accessible as the proceedings of the British Association, by professor H. Rogers' Report on the Geology of America, published in the fifth volume of the Transactions.

We have now traced the primary range through the State of Massachusetts, and must next follow it into New Hampshire, where it constitutes the White Mountains, which have hitherto been considered the loftiest group within the compass of the

United States, exceeding by 2000 feet at least the greatest elevation which the Alleghany mountains were known to have attained.

If, however, we can rely upon the report of professor Mitchell of Chapel Hill University, which will be seen in a late number of Silliman's Journal, it would appear, that the Alleghanies reach in North Carolina a height greater even than that of the White mountains, and far exceeding that of the Peaks of Otter in Virginia, which were before considered the most elevated spot in that range.

Thus, whilst the Peaks of Otter are only 3,955 feet above the level of the sea, and even mount Washington, the highest peak of the White mountains, does not exceed 6,234, it is stated that the Black mountain in North Carolina is no less than 6,476 feet, and the Roan mountain in the same state, the next in point of altitude, 6,038 ^b.

The White mountains, which constitute the culminating point of the Alleghanies on their northern extremity, present in general a series of circular wavy detached masses with rounded flat summits. They consist chiefly of gneiss, granite being found only in a few places. Professor Hubbard of Dartmouth College, New Hampshire, has described the occurrence of trap dykes intersecting the above-mentioned rocksⁱ.

The same chain continues into Canada, but is there found at a much lower level. Near Quebec it forms a range of hills above 1000 feet in height, and is afterwards seen in the northwest bank of the St. Lawrence to an extent hitherto unexplored.

^b See Am. Jour. vol. xxxiii. p. 322, and vol. xxxv. p. 377.

ⁱ See Am. Jour. vol. xxxiv. p. 108.

Such then is the direction of the primary ridge on the eastern side of Lake Champlain, but another portion of the same, divided from the former by the valley in which these lakes occur, is found to rise to the west nearly to as great a height; for in Essex County, State of New York, the highest peak has been estimated, by barometrical measurement, at 5,400 feet.

It affords a remarkable proof of the imperfect knowledge we possess of this vast continent, notwithstanding all that has yet been done to advance it, when we find that in the State of New York, one of the most populous perhaps, and the longest settled in the union, Massachusetts and Connecticut excepted, one district, in which such lofty mountains are situated, should have remained unexplored till the year 1837, when a body of naturalists from New York first made known to their countrymen their situation and height.

This exploring party was compelled, from the nature of the country, to proceed in the same manner, and with the same precautions, as they would have done in the wilds of the extreme west, carrying with them their store of provisions, bivouacking at night in the woods, and varying their scientific occupations by encounters with wolves and panthers^j.

The rocks of this district differ from those seen in the Alleghany chain to the south, but agree with others which appear to abound in high latitudes in Canada.

They seem to consist principally of Labrador felspar and Hypersthene rock, like the Cuchullin

^j See in Am. Jour. vol. xxxiii. a Memoir by Mr. Redfield.

hills in the Isle of Skye, and like them are occasionally intersected by large dykes of trap. A blue limestone stratum is said to overlie the primary or crystalline rocks above mentioned, and this has undergone a very remarkable conversion, near the line of contact, into a white marble spangled over with minute specks of anthracite, just the same that has happened to the limestone of New Jersey, as will be particularly noticed, when we come to speak of the rocks resting upon those of the Blue Ridge, on their western flank.

Betwixt the two groups of mountains above described are situated lakes George and Champlain, and a continuation of the same valley farther to the south receives the river Hudson, from Albany to New York.

From Essex county, the mountains above described stretch westward to Kingston in Upper Canada, where they join, and become blended with, another low chain, which stretches across the continent from south-east to north-west.

This chain has been traced by Dr. Bigsby, from the Thousand Islands, at the outlet of Lake Ontario, along the northern shores of lakes Simcoe, Huron, and Ontario. It probably extends uninterruptedly to the Rocky Mountains, although from the notes transmitted to the geological society, by the late lord Selkirk, it would appear, that primary rocks were lost sight of about Lake Winipeg, and that the prevailing formation was there calcareous.

The limestone seen resting on the flanks of the primary chain, on the borders of Lakes Huron and Superior, appears to belong to the same period as that of Trenton and Quebec, containing *Orthocera-*

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tites, Trilobites, Cyathophylla, and numerous other Corallines, some of which are new.

The Rocky, or Chippeway Mountains, as they are more appropriately termed, extend from north-west to south-east, in a line nearly parallel with the coast of the Pacific, from which they are in general from 500 to 600 miles distant.

They stretch from the Isthmus of Panama, nearly to the Arctic ocean, being found by captain Franklin far north of the Mackenzie river. Thus they form the boundary which separates California and the Oregon territory, from the vast prairies which lie to the west of the states of Arkansas and Missouri.

The base of these mountains is calculated at 300 miles in breadth, and their loftiest summits, which are covered with perpetual snow, are generally said to reach the height of 12,000 feet, but professor Renwick of New York, calculates them at nearly double this height. At the few points at which they were examined by the earliest explorers of the country, they were found to consist of primary rocks, granite, gneiss, quartz-rock, &c. and on their eastern flank an extensive formation of red sandstone was remarked.

But more recent travellers have noticed, in various parts of the chain, volcanic rocks very generally distributed, and although the reports of unscientific persons may not be precise enough to convince us, that the rocks they describe belong to the class of subaereal lavas, yet we may gather from their accounts sufficient indications of the fact, that volcanic operations have continued to a very late epoch, and even yet are not wholly extinct.

This appears to be particularly the case in the

west of these mountains, where the same line of igneous operations is continued, which exists more to the south in California.

Hot springs have been discovered in several parts of the chain, and it seems probable, that some of the salt lakes met with amongst the mountains may prove to have been the craters of extinct volcanos.

In a wide sense then, it might be said, that the central portion of the North American continent is surrounded, on the north, east, and west, by a chain of primary formations, and that the entire space included betwixt the Alleghany and the Rocky Mountains constitutes the great valley of the Mississippi.

But in giving it this name, we must not be led to imagine, that the whole intermediate tract is filled up with alluvial or with tertiary deposits, or to suppose, that it maintains throughout an uniformly low level.

Such a description, indeed, applies to the district included within an area of about a hundred miles to the westward of the Mississippi river, so far at least as the point where the junction takes place between it and the Ohio, and it might also serve to designate an equal extent of country to the east of this great vein of the American continent; but the low alluvial tract here alluded to, which is probably composed entirely of the deposits from the river, and which once constituted an arm of the sea, communicating with the Gulf of Mexico, is bounded by the western portion of the Alleghanies to the east, and by a ridge, consisting of clay-slate, quartz-rock, and sandstones of various degrees of consistency, which I myself followed from the hot-springs on

the river Washita, in the state of Arkansas, to St. Louis, in the state of Missouri, a distance of nearly 400 miles.

The only rocks, that seem to break the uniformity of character belonging to this range, are certain porphyries near the mining district of Missouri, with which are associated large protruding masses of specular iron ore.

These have been noticed by Mr. Featherstonehaugh in his Geological Report, and appear to constitute one of the largest accumulations of ferruginous matter in the world.

They enter largely into the bulk of an elevation called the Pilot Knob, standing up about 500 feet above the level of the neighbouring country; and entirely compose another called the Iron Mountain, about 300 feet in height, and two miles in circumference^k.

At the base of this latter hill a company from the eastern states have projected a new city, which makes an important figure on paper, and is represented in the Plan as having already started into existence; as being connected by two railroads with the Mississippi, and by another with Santa Fe in Mexico; as the seat at once of learning and of manufactures; and as containing already within

^k Prof. Shepard, Lecturer on Natural History at Yale College, Connecticut, and on Chemistry at Charleston, S. Carolina, has also given an account of these rocks from personal examination.

He informs me, that a region of red granite, frequently intersected by trap dykes, prevails for a breadth of at least six miles, between the compact felspar and porphyritic range; (which bears the specular iron deposits;) on its eastern border separating the iron region from the metalliferous transition limestone.

itself churches, parks, colleges, and all the accompaniments of civilisation¹.

¹ I insert the Prospectus, as a curious specimen of effrontery on the part of the projectors of this scheme, such as (without hazarding an opinion as to its feasibility) I may venture to say would only have been attempted amongst a people possessed by a rage for speculation, to the degree which belongs to the American character.

" PROSPECTUS.—Missouri City is situated on a beautiful plain, at the base of the celebrated Iron Mountain, 90 miles south of St. Louis, and 40 west of the Mississippi river. It is the central point of all the chartered and contemplated railroads in South Missouri. Climate remarkably bland, as healthy as any part of the Eastern States. Winters mild. Scenery mountainous, and beautiful as that of the North river. Springs of the best water, abundant, and clear as crystal. Pine lumber abundant, at one cent a foot. Brick, limestone, marbles, and granite building stones, abundant, of the best quality, and near by. Farming lands in the vicinity equal to the best in the west. Rich mines of lead, zinc, copper, tin, &c., also two Iron Mountains in the neighbourhood. The Missouri Iron Company, with a chartered capital of 5,000,000 dollars, will make this place the seat of a part of their iron works. The Missouri City University, with an endowment of 75,000 dollars a year for 45 years, will be located as represented in the City plot. *Education in this University gratuitous to the citizens.* The proprietors have given to the University 1000 acres of land near the City for a manual labour and experimental farm; also to the City, grounds for 62 public parks, 8 churches, 2 markets, 6 asylums, 1 City hall, 1 City lyceum, 2 hotels, all the University buildings, 1 young ladies' institute, 4 public schools, a City burying ground, and a City flower garden. No dram shop, lottery, gambling office, or house of ill fame, ever to be allowed in the City or on the lands within three miles. No slaughter, butcher shop or yard, or tan yard; no glue, starch, candle, soap, turpentine, powder, or oil manufactory, or any other kind of manufactory tending to infect the air, or annoy the neighbourhood, to be allowed in the City limits.

" Communications, post-paid, directed to Missouri City, St. Francis Co., Mo.

" J. L. VAN DOREN, } Proprietors."
 " HENRY PEASE, }

Having, whilst in Philadelphia, seen and perused the Prospectus, I made a point of visiting the spot, in expectation of finding there something resembling a town; but, to my surprise, could discover but one solitary house occupied by a person from New York, who had been induced to take up his abode in the wilderness for the purpose of making bricks for this nascent metropolis.

All the surrounding tract of country for many miles, including the Iron Mountain itself, "*this central point of all the chartered and contemplated railroads in South Missouri,*" was, with the exception of a small farm about the premises alluded to, in as untamed a condition, as it could have been when the red Indian roamed freely through its recesses; and still furnished, if I may judge by my own experience, an unmolested retreat to the rattlesnake.

Near the Warm Springs on the Washita River, in the state of Arkansas, I observed a considerable mass of the same ore of iron, constituting what is termed the Magnet Cove. The term *cove* in the American sense, implies, not necessarily the presence of water, but simply a circular hollow, and the rocks immediately surrounding this, consist, according to Featherstonehaugh, of greenstone, whilst the soil covering the hollow itself is scattered over with detached blocks of magnetic iron ore, the relation of which to the trap formation does not seem as yet to be made out.

We perceive then, that the valley of the Mississippi, in the more limited sense in which I now employ the term, is inclosed by a range of primary

rocks, on the north, east, and west ; but that on the south all traces of this class of formations are lost, the only ones that appear at the surface being green-sand and tertiary strata, as we observe in Tennessee, and in the more southern portions of Arkansas^a.

The highest portions of the Alleghany ridge, properly so called, of which we have any geological information, (for the White Mountains are not commonly regarded as constituting a part of that chain, and the rocks of North Carolina have not as yet been described,) appear to lie in Virginia and in Pennsylvania ; and here too, as might be expected, the rocks superimposed are found to be most tossed about, and most highly inclined, whereas in other parts, as in Canada, the primary rocks are less elevated, and the newer formations superimposed more horizontal. Thus near Quebec we seem to have evidence, that no elevation of the strata has taken place since the deposition of the dark-coloured fossiliferous limestone of that country, which is probably of higher antiquity than the carboniferous limestone of this country.

This appears from the fact, that at the celebrated Falls of Montmorenci, where we have a section of this rock, it is seen to rest unconformably, in horizontal strata, upon highly inclined beds of clay-slate, which are incumbent upon syenite.

^a My friend Mr. Lea of Philadelphia, who is well known as an accurate conchologist, and an extensive collector in this and other departments of natural history, has described and figured in a very beautiful and correct manner a series of shells obtained from Claiborne in Alabama, which he regards as belonging to the London clay and calcaire grossier. They are found about 200 feet above the level of the Alabama river, which runs into the gulf of Mexico, and 90 miles from its mouth.

Just above the Falls, the limestone forms a series of irregular natural steps, in a ravine worn by the river in its descent to the St. Lawrence.

The greater part of Canada appears remarkably distinguished for the level character of the country.

No elevated range of mountains is known to exist between the lakes and the distant coast of Labrador, although the level of the country is generally found to rise as we proceed north, up to a certain latitude, and although the rocks are composed of granite, syenite, and still farther north, of hypersthene rock and saussurite.

The absence of any lofty chain of mountains stretching from east to west, like the Alps, the Pyrenees, and several other associated chains in Europe, ought doubtless to be included amongst the causes already enumerated by Humboldt, as accounting for the extreme cold which pervades the whole of this continent to a very low parallel during winter^b.

The chill blasts proceeding from the North Pole have thus no material barrier in the western hemisphere, to impede them in their progress towards the south.

The great system of lakes, indeed, which divides

^b In the Eighth Report of the British Association for the Advancement of Science, p. 29, I have given a statement of the mean temperature of various places in North America, from the best observations I could collect, and, amongst others, of Quebec and Montreal, in the Canadas, in the parallels of 46° and 45°, and of several places in the state of New York, &c. in parallels 43° and 42°. But these results convey a very imperfect notion of the cold to which this continent is subject; its rigor may be gathered, from the failure, even in the latitudes of Philadelphia and Baltimore, of the common evergreen shrubs naturalized in

Canada from the United States, considerably moderates the cold of the winds that sweep over their surface, and thus exercises a favourable influence upon the climate of the country immediately adjoining its southern coast.

But a mere inspection of the map will convince us, how very partial their operation must be, since the whole tract, extending from the east of Lake Ontario to the Atlantic, is destitute of any such protection.

That portion of the American continent therefore which is comprehended within the geographical limits of the two Canadas, presents, wherever it has yet been explored, only a limited range of strata; but south of the great lakes, in the north-western portion of the State of New York, we find the geological features of the country somewhat more diversified.

I have already noticed the primary range, which is so developed in Essex and St. Lawrence counties, and which extends to the Hudson river at West-point, under the name of the Catskill Mountains.

This range divides the basin of the Hudson from that of the Mohawk at Little Falls, where a chasm occurs in it, through which the river now discharges its waters.

northern Europe; from the necessity of protecting the vine during the winter in the equally low latitude of Cincinnati (parallel 39°); and from the occasional destruction of the orange and lemon (which grow without protection at Falmouth) by frosts, so low as at Charleston, S. Carolina, and even as at New Orleans.

From the register kept at Fort Diamond, Quebec, it appears, that the thermometer occasionally falls there to 40° below zero, and even at Montreal it has been seen at —23°.

But this primary chain, extending from Little Falls, on the south-east, to Kingston, in Upper Canada, on the north-west, serves as the basis, upon which the fossiliferous rocks of the west and south-west of the state repose.

These, according to Mr. Vanuxem, all dip in a southerly direction, so that as we proceed from the borders of Lake Ontario to the frontier line of Pennsylvania, we get successively higher and higher in the series, till at length we reach the carboniferous system, which is so extensively developed in the latter.

The junction of the primary and fossiliferous rocks is to be seen at Little Falls, where an upheaving has taken place, which has brought the lower beds immediately resting upon the primary, up to a higher level, on the northern side of the valley, than is occupied by the newer ones on its southern.

The following, according to Mr. Vanuxem, are the rocks seen in succession in the district described in his Report for 1838.

Resting unconformably on the gneiss observed at Little Falls, is a calcareous sandstone, containing many quartz crystals and imbedded masses of anthracite.

Imperfect *fucoides* are the only fossils in this rock, and from this are supposed to be derived the portions of anthracite it contains.

Incumbent on this is a calcareous rock, called *bird's-eye limestone*, much used as a building stone, which is characterised by vertical stems of *fucoides demissus*.

Next occurs the limestone of Trenton Falls, remarkable for the number and interest of its

fossils^c, which appear to identify it with that of Montmorency, near Quebec, and that of Glen's Falls, below Lake Champlain.

The series of cataracts, from which this spot derives its celebrity, seems to arise from the same cause as that which produced the gigantic one at Niagara.

In both cases the limestone, over which the water abruptly descends, rests upon beds of loose friable shale, which, having been undermined by the action of the waters, deprived the incumbent limestone of its support, and occasioned the sudden termination of large masses of the latter. Hence, instead of the gradual slope, which would probably have been brought about by the flow of water over strata that opposed throughout an uniform resistance, we meet with a succession of waterfalls, caused by the precipitous escarpments which the rock presents.

The green shale and sandstone rock, which alternates with, and finally rests upon, the Trenton limestone, is characterised by various shells, some peculiar to itself, and others common also to the calcareous bed which supports it.

It is succeeded by a rock, called by Mr. Vanuxem, millstone grit, containing pebbles of quartz; and upon this reposes a series of green and blue shales, and of red and white sandstones, with oxide of iron and gypsum, which he calls the *Protean* group. The latter abounds in fucoides, but contains few

^c The following is a list of the fossils :

Leptæna alternata,	Calymene Blumenbachii,
Delthyris striatula,	Cryptolythus tessellatus,
Orthoceras striatus,	Isotelee gigas,
Bellerophon apertus,	Isoteles cyclops.
Favosites,	

shells; the numerous brine springs of the north of New York State rise principally through it.

Other descriptions of shale and limestone occur above, one of the newest of which contains trilobites, and other fossils of such a nature, as to identify the whole of this series, as parts of a common group, and as deposited within the same geological epoch.

The correspondence of the whole with the Silurian rocks of *Murchison* is confidently affirmed by *Mr. Vanuxem*^d; and I have already stated, that another geologist, attached to the same corps (*Mr. Conrad*), even goes so far as to identify distinct beds with the several subdivisions of this formation, as it exists in our own country.

Upon the above-mentioned rocks is deposited a series of shales, sandstones, and limestones, which have been principally explored in the western portion of the state, where, owing to the general bearing of the rocks being to the northwest, the newest members of the series are found along the line of the Erie Canal, or in the country immediately to its south.

Mr. Hall, the conductor of this portion of the survey, considers these as belonging to the old red sandstone and carboniferous groups, and as lying above the Silurian system. Trilobites are found only in the lower beds of this series.

Along the Genesee river, from its embouchure on Lake Ontario upwards, a series of these rocks is

^d who enumerates, orthocera, trilobites, producti, spirifers, pentameri, and favosites, and on the authority of *Mr. Conrad*, eurypterus, catenipora, conularia, and monotis, as the fossils found in it.

exposed, and a dark-coloured calcareous shale, which occurs at the Upper Falls, above Rochester, as one member of the series, has been traced to the Falls of Niagara, where it underlies the limestone, over which the waters there precipitate themselves.

The cataract itself, as is well known, occurs in the bed of the river which discharges the waters of Lake Erie into Lake Ontario; and its existence must be attributed to the sudden alteration of level which commences in the rocks above Queenstown, where they form an abrupt escarpment, rising to the height of no less than 370 feet above the alluvial ground at their base.

Now this alteration of level may have been brought about, either by a subsidence of the country to the north of Queenstown, or by an elevation of the rocks above that town to an equal extent on the south of it. The former supposition has been the one more generally resorted to, but I am more disposed to the latter, from having observed, that the strata intervening between Queenstown and Lake Erie, notwithstanding their near approach to horizontality, appear nevertheless to possess a slight inclination towards the south*.

This may be inferred, I think, from the circumstance, that the shales which underlie the limestone of the Falls, occupy a higher level on the heights above Queenstown, than they do farther to the south; whilst other subjacent strata, which lie concealed beneath the bed of the river, on the site of the present Cataract, are here seen cropping out from beneath.

* See this statement confirmed by Mr. Hall, in the Report of the Geological Survey of New York State for 1838, p. 370.

Hence, as we proceed along the margin of the river from Buffalo to Lewiston, we observe in the first place, at Black-rock, a dark coloured, fœtid, bituminous limestone, full of cherty concretions, which I take to be the upper bed of the calcareous formation seen at the Falls: secondly, the subjacent portions of the latter, often dolomitic, and containing much gypsum, which are 90 feet thick at the Falls, but diminish to 20 feet at Lewiston; thirdly, the shales underlying the last mentioned rock, which may be seen sinking beneath the bed of the river at the Cataract, but rising considerably above it near Queenstown; fourthly, a white, compact sandstone, first coming into view beneath the shales on the edge of the escarpment; and lowest of all, friable beds of red marl, occupying the bed of the river, in the alluvial plain which extends from thence to Lake Ontario.

Now if we imagine the whole series of rocks, from this place to the borders of Lake Erie, to have been upheaved, we shall find no difficulty in referring to the same movement, the inclination towards the south which they likewise seem to possess—whereas a subsidence of the country, north of the escarpment at Queenstown, would rather have had a tendency to cause the rocks contiguous to slope *towards* the depressed portion of the country, than in the contrary direction.

Let us suppose, then, that an elevatory movement had taken place at some distant period, by which the country intervening between the two lakes, as far as Queenstown, attained its present position, whilst that to the north, bordering upon Lake Ontario, remained undisturbed.

Such an alteration of level would have cut off the

communication between the two lakes, assuming them to have been then in existence, or it would have ponded up the waters flowing through the valley in which Lake Erie is situated, until they had overflowed the low country above the Falls, and had reached the heights of Queenstown.

Here then, we may imagine the original waterfall to have occurred, and the cause of its retrocession, to the spot at which we now find it, must be sought for principally in the yielding nature of the strata upon which the superficial rock reposes.

The latter, as has been observed, is a compact limestone, which would yield but slowly to the erosive action of the waters; the former, a loose shale, which would be easily undermined and carried away by them.

Precipitated, as at present, over a ledge of hard rock, to a depth of 164 feet, this sheet of water, when it struck the pool beneath, would send forth a blast of spray and wind, which, striking against the crumbling shale beneath, would gradually disintegrate it; until the incumbent limestone, deprived of its support, itself fell, and the Cataract consequently receded.

Such is the course of operations witnessed at the Falls at present, and such must have been the case from the time the Cataract began to exist, whatever may have been the point at which it originally stood.

Writers, in general, have agreed in fixing for this spot upon the heights above Queenstown, and upon this assumption have speculated upon the length of time that would have been required, for the recession of the Cataract to its present site near the village of Schlosser, 7 miles distant.

It has been calculated, that the present rate at which the Cataract recedes, is about 50 yards in 40 years, so that it would have been nearly ten thousand years in falling back to its present point, and would require 36,000 more before it reached Lake Erie, the nearest point of which is still 25 miles to the south of it.

But it must be confessed, that all the points here laid down are assumed on very insufficient grounds, and may each of them admit of dispute.

In the first place, granting that the Cataract originally stood at Queenstown, granting that its present rate of retrogression is correctly stated, and granting moreover, that it has been at all former periods the same as it is now observed to be, still it by no means follows, that it will continue to travel backwards at the same average pace hereafter.

For this to happen, would imply, not only a degree of resistance in the superficial stratum, as nearly as possible corresponding to that which it opposes to the action of the water at present, but likewise the existence throughout of the same friable shales underneath it, at such a level, as would allow of their being attacked and undermined, as they are now, by the spray proceeding from the Cataract.

Now the latter supposition will appear an extremely improbable one, from what has been already stated with respect to the dip of the strata, which must cause the shale to sink below the bed of the river, before it reaches the site of Lake Erie.

A still further retrogression of the Cataract (observes Professor Rogers^f) will bring the Cataract altogether out of the inferior shale, the thickness of which is at present only 90 feet, and when that is the case, the further action of the waters upon the

^f Silliman's Journal, vol. 27, on the Falls of Niagara.

surface of the limestone, will produce a series of rapids or minor falls, and not a single stupendous one as at present.

But it has even been questioned, whether in point of fact the waterfall ever stood so far back as the heights above Queenstown, and recently a correspondent in Silliman's Journal^s maintains, on distinct and independent grounds, that the most remote point at which it could ever have existed was not more than three miles below its actual position.

If such however be the case, we must assign some cause for the scooping out of the deep and precipitous ravine, which extends from the supposed point to the termination of the high ground above Queenstown, distinct from the action of the river which now occupies it, and here I am not quite satisfied with the explanation given.

At any rate, these rocks would seem to have been elevated at some period, geologically speaking, not very remote, for otherwise we might expect, that they would ere this have been scooped out by the action of the waters as far as the shores of Lake Erie, and we should now behold a succession of rapids along the whole extent of Niagara river, instead of one abrupt fall of water, as at present, between the two Lakes.

It seems hardly necessary for me to enlarge upon the inconsistency of the above statements, with a theory that has been advanced by certain geologists, who have suggested the probability of an enormous flood deluging the surrounding country at some future period, owing to a sudden drainage of Loch Erie, which is to be brought about by the retrocession of the cataract to its borders.

^s Mr. Hayes on the Geology of Western New York State.

But, I may add, that even if we grant that the cataract will work its way back to this distant point, it by no means follows, that a sudden drainage of the lake will be the consequence, since (as Mr. Delabèche, and others^h, seem to me to have satisfactorily shewn) the volume of its waters will have previously been much reduced by the gradual drainage of it, which will begin to take place, so soon as the cataract shall have receded to a point on the *plateau*, over which it falls, where it will stand at no higher level, than that of the upper surface of the existing lake.

I shall however refer to Mr. Delabèche's Manualⁱ for a more full and clear exposition of this part of the subject.

With respect to the Fall itself, considered in a picturesque point of view, or as influencing the imagination and feelings, it may seem an odd confession to make, that my first feelings on visiting it were not unmixed with disappointment.

Of an object so long known by report, each person, before he reaches the spot, conjures up in his mind some sort of idea, which in certain respects must differ from the reality, and may therefore lead him to imagine the latter as falling short of his previous conceptions.

Thus I had imagined, that the fury of the waters, after they had been launched over the cataract, would have been more terrific, and was surprised at seeing the ease, with which an insignificant ferry

^h See H. Rogers on the Falls, Silliman's Journal, vol. 27.

ⁱ Third edition, p. 59.

boat crossed the stream within a very short distance below^k.

The noise produced by the waterfall itself, I had also conceived, would have been more stunning; and it was with a feeling nearly allied to what one might entertain, at hearing a person of solid weight and character talked down by a noisy upstart of yesterday, that I found the roar of this stupendous natural phenomenon overpowered by the hissing of a Locomotive, which was letting off its steam at the railroad station adjoining.

The presence of these evidences of human ingenuity was in other respects also very unpropitious to the feelings which the scene itself was calculated to inspire, and though no enemy either to railroads or factories in their proper place, I could have wished all vestiges both of the one and of the other banished from a spot, where nature ought to be allowed to reign undisturbed and alone.

But after a time, these first prepossessions wore away, and I then began to feel more impressed with the solemnity of the sound which the cataract produces in its descent, than I had expected to have been by the deafening tumult of waters for which my imagination had prepared me.

In surveying it too under various aspects, and at different distances, I found new sources of admiration and astonishment continually presenting themselves, of which I had previously no conception; nor did the interest of the scene appear to flag, when I turned to contemplate the phenomena presented in the course of the river both above and below,

^k This however is owing to the backwater, which counteracts in a great degree the force of the current.

which may be regarded either as concomitants, or as consequences, of the cataract itself.

Writers indeed have spoken of the scenery in the neighbourhood of the Falls as tame and uninteresting, but they cannot mean to extend this remark to any portion of the river itself, which, from its origin at Buffalo to its termination in Lake Ontario, presents everywhere a succession of the grandest and most striking objects.

To begin with the point at which it terminates in Lake Ontario.—From the above spot to Queenstown, where we meet the escarpment at which the cataract has been supposed to have originally stood, the river meanders beautifully through a level country, within a wide channel, and with a current comparatively slow, so that thus far steamers meet with little difficulty in ascending it.

But from the commencement of the cliffs at Queenstown to the Falls themselves, the river is hemmed in by deep precipitous banks, and flows with a rapidity, which even from the first is greater than any machinery can contend against, and which becomes still farther augmented higher up. On reaching a point in its course about three miles below the Falls, the foam and noise of the waters indicate the increased violence of the current, and here, in consequence of a bend in its channel, by which the stream is deflected from its direct course both to the right and left, occurs the whirlpool, in which objects once committed to the waters are either carried round and round with great velocity for an indefinite period, or, being sucked into the eddy at the centre, are drawn down to a great depth.

At this point opens the first view of the Falls from below, and it is perhaps one of the best sta-

tions from whence to contemplate them, in consequence of the two masses of water, which are seen separately on approaching nearer, being at this distance blended into one, and appearing like one continuous sheet of foam, shining and sparkling in the sun's light.

Arrived at the village on the American side opposite the Falls, which goes by the very unromantic name of Manchester, the first object that attracts our notice is the eastern branch of the Niagara river, rushing with the greatest impetuosity down to the point, where it is precipitated over a reef of rocks, and constitutes what is termed the American Fall.

This branch of the stream is divided from the Western or British, by Goat Island, a small tract of land standing up in the midst of the waters, based on the limestone ledges which form the rapids, but composed below of loose alluvial deposits, which could offer no effectual resistance to the current, if the latter had not been turned aside from them, both on the right and left, by the hard calcareous rock which bears the direct brunt of its violence.

Goat Island is connected to the main land by a wooden bridge, thrown across the rapids, of a very bold construction, by means of which, we are enabled to avail ourselves of the many favourable positions for contemplating the rapids and the cataracts, which its central position affords.

A staircase, enclosed in a kind of wooden tower, which descends to the very level of the river, enables us to reach the water's edge between the two Falls.

Here, when the wind blows the spray in the reverse direction, it is practicable to proceed a certain distance under either sheet, and thus to obtain a

near view of the waters dashing over the cliff, whilst we stand in the space between them and the rock.

Seen by the light of the sun transmitted through them, they appear perfectly sea-green, until having descended the precipice, they become dissipated in foam.

Perhaps, however, the view of both Cataracts from a little greater distance, surpasses it in beauty, especially when the sun shines brightly enough, to produce in all their brilliancy the hues of the rainbow, which it occasions in the mist arising from the spray of the descending waters.

On the verge

From side to side, beneath the glittering morn,
An Iris sits, amidst the infernal surge,
Like Hope upon a death-bed, and unworn
Its steady dyes, while all around is torn
By the distracted waters, bears serene
Its brilliant hues with all their beams unshorn :
Resembling, 'mid the torture of the scene,
Love watching Madness with unalterable mien.

Such are the most striking features exhibited on the American side ; but the views obtained on the Canadian are perhaps of a still more sublime character.

At the Table Rock, where the removal of the subjacent shales has occasioned the solid limestone to project several feet forwards, we may approach almost within reach of the Horse-shoe Fall, and contemplate at our leisure the waters of this, the more considerable portion of the Niagara River, beating over the face of the precipice, and precipitated to a depth of more than 160 feet.

Or we may descend the cliff over which the waters are projected, and accomplish, with no other

risk than that arising from a thorough wetting, the apparently formidable undertaking of passing behind the falling waters, in the interval between them and the face of the rock.

The whole effect of the scenery at the Falls was enhanced by the height and abruptness of the banks on both sides of the river, and, at the season I visited the spot, by the exceeding richness of the autumnal tints exhibited by the trees that hang over the face of either cliff.

It was, as if the fissure in St. Vincent's Rocks at Clifton, now occupied by a dark, muddy river, which looks like the outscourings of a large commercial city, had given passage to a deep pellucid stream, which, instead of flowing languidly along its oozy bottom, was urged with impetuosity over projecting masses of rock, foaming and roaring in its course, and finally precipitated to an immense depth over a perpendicular cliff.

Add to this, the greater dimensions of the channel, and the larger volume of the water it contains, being indeed the whole of that immense tribute, which the lakes, or rather seas, of Erie, Huron, Superior, and others, are pouring into the lap of the Atlantic.

Formerly it might have seemed hyperbolic, to have pronounced a sight of the Falls, as in itself worthy of a voyage across the Atlantic; but at present, when steam navigation has in a manner shortened by more than one-half the distance that separates the two hemispheres, it is not too much to affirm, that a visit to Niagara, coupled with a view of the enchanting scenery presented in the journey to it, will afford to most European travellers an

ample compensation for such discomforts, as may be calculated upon during a summer passage to America.

But to proceed with subjects more immediately connected with the purport of this Memoir. It seems pretty evident, that a considerable sinking of level must have taken place in the waters of the Great Lakes. This is proved by the terraces, (or ridges, as they are perhaps less properly termed in America,) which are more or less distinctly seen, extending along either shore of Lake Ontario, as well as of Lake Erie.

The height of the terrace above Lake Ontario, in Niagara county, is about 160 feet, and its position is nearly parallel to the present shore of the Lake, which is from four to eight miles distant. It is composed of sand, gravel, and pebbles, similar to those forming the beaches along the present Lake shore, and its existence can only be explained, by supposing the water of the Lake to have once stood at that level.

I travelled on this ridge, which forms an excellent natural road, all the way from Lockport to Rochester, and observed one similar, though less distinctly marked, at a certain height along the borders of Lake Simcoe.

Having now described some of the principal formations that rest on the flanks of the primary ridge, in the northern portion of the Union, I next proceed to notice those which occupy the same relative position, in the States of New Jersey, Pennsylvania, and Virginia.

In the first of these countries Professor Rogers has described a series of strata, resting upon the primary rocks of the Blue Ridge, and yet all dipping under the coal formation of Lehigh, in Pennsylvania.

The uppermost formation, or that nearest to the coal, may be described as a triple series, consisting of a dull bluish slaty limestone, abounding in organic remains; of a bluish, sometimes reddish, calcareous slate or shale; and of a grey, and sometimes slaty sandstone.

The limestone contains many organic remains: shells of the genera *Productus*, *Spirifer*, *Unio*, &c.; *Cyathophylla*, and other Zoophytes; together with more than one undescribed species of *Trilobite*.

This upper formation rests on beds of red and grey sandstone, underneath which is a series, consisting of at least two slate and two limestone formations, in apparently regular alternation.

The most remarkable circumstance relative to these beds, is the conversion of the ordinary blue limestone, into white crystalline marble, where it approaches the gneiss.

In Orange County, for about 25 miles in extent, occurs a range of this material, containing various interesting and rare minerals; such as *Franklinite*, *Red Oxide of Zinc*, *Spinel*, *Brucite*, *Ceylonite*, *Tourmaline*, &c.: in all, no less than 43 species.

The metalliferous veins, it may be remarked, are directly at the junction of the crystalline limestone with the primary strata.

In various parts of what are called the Highlands of New Jersey, beds of limestone occur, enclosed between the primary ridges, with similar characters.

The limestone has often much the appearance of the Tiree marble of the Hebrides ; but the mineral principally disseminated through it is Graphite, which pervades it, in glossy black specks of the size of a pin's head, and upwards.

The sandstones and shales are likewise much indurated for several hundred feet from the Trap Dykes that penetrate them ; and several interesting minerals are met with in the altered portions.

Farther to the South, the series of formations, extending from the Blue Ridge to the valley of the Mississippi, is at present undergoing examination from Professors William and Henry Rogers : the former of whom has already published three successive, but brief, reports on the Geology of the State of Virginia, and the latter, two similar ones on that of Pennsylvania.

In these publications the authors agree in distinguishing no less than twelve rock formations ; the lowest of which is incumbent on the rocks of the Blue Ridge, and the highest supports a coal formation, which, from the character of its vegetable impressions, has been regarded as corresponding in age with that of the slate coal of England, and other European countries.

If the latter proposition be admitted, it is evident, that the rocks, upon which the coal reposes, and which form the immediate subject of the Professor Rogers' examination, are either the *same* as those of the Silurian system of Great Britain, or at least bear the same relation to the coal field of America, which the Silurian rocks do to that of England ; and it would be superfluous for me to point out the importance of determining whether the former or the latter of

these suppositions be the true one : considering that the whole question, as to the uniformity of the older deposits in distant portions of the globe, hinges upon it.

Unfortunately, the data for this inquiry are still wanting ; no complete lists of the organic remains found in the rocks of the Alleghany mountains having yet been presented to us ; and, when they have been noticed, the genus only of the fossil having, in many instances, been decided on.

The deposits alluded to, form, in general, a more elevated portion of the Alleghany chain, than the unstratified rocks that constitute the Blue Ridge, and lie exclusively to the north-west of the latter ; no strata in this part of the country, belonging to the above series, or of equal antiquity with it, being found to the east of the Blue Ridge.

A concise description of these several formations has been given by Professor William Rogers, in his two latter memoirs ; but we owe to his brother a more compendious view of the whole series, contained in the second annual Report on the Geological Exploration of Pennsylvania ; which will represent the succession of strata developed in the one, as well as in the other, of these neighbouring states.

I shall therefore subjoin the Table, as it stands, with no addition, but that of appending to it, in a separate column, the localities, in which, according to Professor W. Rogers, the corresponding strata are seen best developed within the confines of Virginia, and with no further remark as to its contents, excepting to point out the enormous aggregate thickness of these deposits, which, though belonging to only one geological epoch, amount to at least 40,000 feet.

Table shewing the Order of Stratification, Geographical Position, Composition, and the Maximum Thickness of the Lower Secondary Formations of Pennsylvania, east of the Susquehanna river.

<i>Formations in the ascending order.</i>	<i>Geographical Position.</i>	<i>Usual Composition.</i>	<i>Maximum Thickness.</i>	<i>Where best seen in Virginia, according to Prof. W. Rogers.</i>
XIII.	Anthracite coal basins.	Dark blue shales, bluish grey argillaceous sandstones, and coarse quartzose conglomerates, and seams of Anthracite coal.	6750 ft. nearly at Pottsville. Not yet positively ascertained.	Between the Ohio river and the top of Little Sawell mountain.
XII.	Sharp mountain, and the other mountain barriers of the Anthracite coal basins.	Coarse quartzose conglomerates, alternating with white and grey sandstones, and occasional thin beds of dark carbonaceous shale.	1400 feet. Tamaqua.	Near Lewisburg, Greenbrier county.
XI.	Surrounds the mountain barriers of the Anthracite coal basins, usually in a narrow valley, immediately outside of them.	Red shales and soft argillaceous red sandstones, and occasional beds of compact siliceous red and grey sandstones, also a few thin calcareous bands.	2040 feet. Mt. Carbon.	Expands to a wide area in Pocahontas, Greenbrier, and Monroe counties.
X.	Second mountain, Peters's mountain, Mahantango mountain, Berry's mountain, Line mountain, Little mountain, Cat-tawissa or Nesciopeck mountain, Wyoming mountain, Shick-shinny mountain, and the south-eastern summit of the Allegheny mountain.	White and grey siliceous sandstones, with dark bluish and olive coloured slates, also coarse siliceous conglomerates, alternating with grey, yellow, and white sandstones, and bands of black carbonaceous slate; the latter sometimes erroneously taken for coal slate.	2400 feet, very nearly. Second mountain.	Between the Greenbrier river, and the White Sulphur spring.
IX.	Occupies the north-west part of Pike and Monroe, the eastern part of Wayne, all except the northern side of Susquehanna county, the whole south-east side and base of the Allegheny mountain, and the bases of the mountains consisting of Formation X. on the sides remotest from the Anthracite coal basins.	Red shales and argillaceous red sandstones, also brown, greyish, and buff coloured sandstones.	6000 feet, or more. Below Mauch Chunk, Lehigh.	Hampshire county, Shenandoah or Branch mountain.
VIII.	Middle of the valley between the Kittatinny and Second mountains, valley of Delaware river from Water Gap to Carpenter's Point, middle of Roaring Creek valley, North Branch, from Bloomsburg to Berwick, Muncy hills.	Alternating strata of dark grey, greenish, and olive coloured slates, and grey argillaceous sandstones. Contains many fossils. A stratum of blue fossiliferous limestone near the bottom of the formation.	5000 feet, at least. Below Mauch Chunk, Lehigh.	Ridges of the Allegheny mountain, as in Warm Spring valley, and near White Sulphur spring.
VII.	The sharp rugged ridge next north of the Kittatinny mountain.	A coarse and rather loosely cemented white and yellowish sandstone, with cavities, shewing the forms of shells, and other organic remains.	700 feet. Susquehanna river, Dauphin county.	Mountains in Hampshire, Hardy, Pendleton, Bath, Pocahontas, and Allegheny counties.
VI.	A very narrow belt occurring in places along the northern base of the Kittatinny mountain, and thicker strata along both the northern and southern bases of Montour's ridge.	A blue argillaceous limestone, sometimes grey and sandy, and frequently very full of fossil shells, encrini, &c.	900 feet. Fishing creek, Bloomsburg.	Knobly, Patterson's creek, Bull-pasture mountains &c., Cow-pasture valley.
V.	Northern base of the Kittatinny mountain, and on the sides and summit of Montour's ridge.	Red and variegated sandstones and shales. The lowest layers abound in several species of the marine vegetable fossils called <i>fucoidea</i> .	2000 feet, at least. Delaware Water Gap.	Hardy and Hampshire counties.
IV.	Kittatinny or Blue mountain.	Hard white and grey sandstones, and coarse massive quartzose conglomerates. Contains impressions of several species of <i>fucoidea</i> .	1886 feet. Lehigh Water Gap.	Great North mountain, west of Rockingham and Shenandoah counties.
III.	Northern side of the Kittatinny valley.	Dark fissile slates, usually blue, dark grey, black, and dingy olive, and sometimes drab, yellow, and red. Contains also some beds of sandstone, and a few of conglomerate.	6000 feet, at least. Delaware river, below the Water Gap.	Base and flanks of the Peaked mountain, and the Massanutten &c. in the counties of Rockingham, Page, and Shenandoah.
II.	Southern side of the Kittatinny valley.	A blue limestone, with thin interposed layers of chert.	6000 feet. Not yet ascertained, but probably as much as stated.	West and north of the Blue Ridge.
I.	Southern margin of the Kittatinny valley, and northern side of the chain of hills called the South mountain.	A very compact, rather fine grained white and light grey sandstone.	Not ascertained, but probably 1000 feet.	Western slope of the Blue Ridge.

Now, in Virginia, these several formations are tilted up on either side of an anticlinal axis, which lies at a distance from, and has no connexion with, the older rocks of the Blue Ridge. Thus they rather abut against the latter, than rest upon them, dipping at first to the east, so that they might appear to sink beneath them, and, in spite of many irregularities in the stratification, the general tendency continues to be towards the same point, as far as the line at which the anticlinal axis is situated.

A large portion of the country occupied by this series of rocks constitutes the rich and beautiful valley of Virginia, in which the towns of Staunton, Lexington, &c. are situated.

West of this anticlinal line, the same series of rocks is repeated, but with the general tendency of the stratification reversed, the rocks dipping for the most part, excepting in the case of partial disturbances, to the west, and, as on the other side of this central line, being most tossed about, and most highly inclined near to the anticlinal axis, and becoming gradually more and more horizontal as they recede from it.

It will be perceived from the Table already presented, that the rocks, which the Rogerses distinguish in the tract of country under their examination, have not as yet received from them any characteristic appellations, their identification with European rocks still remaining to be accomplished; although, as has been already remarked, the newest in the series seems to correspond, both in character and in organic remains, with the carboniferous system of England, which it rivals in the abundance of the coal distributed through it, along

the whole of the line of country occupied by it, from Ohio to Tennessee.

In Pennsylvania, the bituminous coal formation appears to bend round to the north-west, extending from Pittsburgh to Towanda, on the borders of the state of New York, and occupying the same relative position, as in the neighbouring state of Virginia.

The whole of this district has been noticed by Dr. Hildreth, in a late number of Silliman's Journal; and it appears from his description that the coal-beds vary from one to twelve feet in thickness, rarely, however, exceeding six feet; that they lie in nearly horizontal strata, with a slight inclination westwards; that they embrace an area of 24,000 square miles, constituting, perhaps, the largest known accumulation of carboniferous matter in the world; and that they usually rest upon sandstone, which appears often to be strongly impregnated with salt.

The vegetable impressions, which he has delineated, as occurring in the coal and accompanying shales, appear to identify the age of this coal with that of our own country.

These, however, are by no means the only situations in which coal exists in the countries alluded to, for extensive deposits of this mineral are found in the immediate proximity of the primary unstratified rocks of the Blue Ridge.

Such is that of Pottsville, which commencing near to the Lehigh, and filling up the valley between the Sharp and Broad Mountains, terminates some miles east of the Susquehanna, and is about sixty miles long, its greatest breadth being five miles.

Another coal field, similarly related, is that of Shamokin, which commences near the Lehigh at Buck Mountain, and terminates at the point of junction of the Big and Little Mahony, being of about the same width as the former.

A third is that of Wilkesbarre, which commences near to Carbondale, and terminates at the Susquehanna, near Nescopeck^a.

Now it is to be remarked, that all these coal fields are *anthracitic*, or destitute of bitumen ; whilst those to the westward of the chain are always bituminous, so that the chemical composition of the coal seems determined by its geological position^b.

There is one peculiarity in the series of rocks just described, which may serve to distinguish them from those of a similar age in Europe, namely, that copious brine-springs gush out every where, from underneath the coal formation, and not from strata of newer date. Such is the case with the brine-springs near Pittsburgh, as well as with those in the state of New York ; nor is there any reason for assigning a more recent origin to any of the very numerous saliferous

^a I am indebted for these particulars to my friend, Mr. Lea, of Philadelphia.

^b Dr. Hildreth remarks, that as we approach the coal-beds in the transition and primitive rocks, the evidences of heat are more apparent, removing from the anthracitic beds, all, or nearly all, their bituminous contents, and in the primitive, changing anthracite into graphite or plumbago. A less degree of heat has been applied to the bituminous rocks of the Ohio, for they are far removed from any crystalline or transition rocks on which the marks of heat are so apparent, and therefore could not receive a sufficiency, to deprive them of their bituminous principles, and change them to carbonaceous coal-beds.

deposits, which, judging from the frequency of springs impregnated with this ingredient, appear to be distributed throughout the interior of this continent.

Near Pittsburgh, the brine-springs rise from a depth of about 270 feet ; on the Connemaugh River at about 500 feet. They are usually accompanied with a disengagement of carbonetted hydrogen gas, which may, however, proceed from the bituminous shales and coal-beds, which rest upon the muriatiferous sandstone.

The brine-springs, which occur in this position in the United States, appear to contain the same ingredients which are common in those of European formations.

I myself detected iodine very copiously in the mother-water from the salt-works of Syracuse, in New York State ; and I find that it has been met with also in the salt springs of Pensylvania.

Bromine I could not discover, but the quantity of the sample which I had brought away was too small, to justify me in inferring the entire absence of this principle from the water experimented upon.

The rocks, from which these springs issue, appear to be accompanied, as in Europe, by very large beds of gypsum, which occurs in irregular, often conical masses, enclosed in a greyish friable marl. This marl is probably impregnated with saline matter, which it imparts to the water that percolates it ; for no beds of rock salt have hitherto been found in the state of New York, although frequent sinkings have been made in the saliferous strata, in the hope of discovering it ; nor indeed ought brine-springs to be considered as affording any certain

indications of its existence, where, as in this case, they are so fully impregnated with the more deliquescent ingredients, which are found in sea-water, but which are altogether absent from beds of rock salt.

If our information with respect to the geology of the eastern states is imperfect, it can hardly be expected, that I should have been able to procure any precise, or detailed account, of the rocks observed in the less explored regions of the west.

The conductors of the geological survey of the State of Ohio, (amongst whom I recognise with pleasure the name of my kind and intelligent friend Professor Locke,) have, however, as I collect from a notice in Silliman's Journal, published their first annual report, in which they have noticed, amongst other formations, a great limestone deposit dipping under the coal, which they regard as the equivalent of the mountain, or carboniferous, limestone of Europe. It is first found in Adams county, and extends thence to the western borders of the state.

Now I have little doubt, but that this is the rock which I had observed in various parts of Kentucky, as near Lexington, Frankfort, &c., and which I afterwards found so replete with petrefactions just above the city of Cincinnati, where it occurs, in great thickness, in strata nearly horizontal, and alternating with beds of marl.

From its general appearance, and from a cursory inspection of its imbedded fossils, I remarked its resemblance to the Dudley limestone of England; and on my return to England, I submitted the spe-

cimens obtained from it, first to Mr. Murchison, and afterwards to Mr. Lonsdale.

Mr. Murchison recognised several of the fossils as resembling those of his own Silurian system, and Mr. Lonsdale, after the more detailed and careful examination to which he has been good enough to subject them, has completely confirmed this suspicion.

The rock at Cincinnati, I may observe, is filled with a profusion of Corals, of Bivalves, and of Trilobites.

The branched Coral which I sent him, Mr. Lonsdale considers to be the *Favosites spongites* of Goldfuss, Tab. 64—70, the tuberculated surface, which it presents, being due only to irregularity in the growth of the animal, there being no characters on which a specific distinction can be founded. In some instances the surface is quite smooth, and a passage from that state to the roughly tuberculated one may be traced in the series of specimens. Now, as may be seen by Mr. Murchison's work, the *Favosites spongites* is an abundant Silurian coral.

Of the shells brought by me from Cincinnati, one appears to be the fossil figured in the same publication, as the "Orthis pecten" of Dalman. Mr. Murchison's specimen is taken from the Caradoc sandstone, and Dalman's probably from some portion of the Silurian system. Mine is the shell belonging to the Genus *Strophomene* of Raffanisque.

The other shells have in general the character of Silurian fossils,—they belong to the Genera, *Atrypa*, *Orthis*, *Spirifer*, *Leptaena* (*Productus*), *Terebratula*, and *Euomphalus*; but although in many of them the resemblance was strong with species figured in

Mr. Murchison's work, I have not sufficient confidence in my power of discriminating minute conchological differences, especially in the case of specimens hastily collected, and therefore not always in the best state of preservation, to venture to pronounce on their identity. Encrinital stems are abundant, and there is likewise the portion of a *Calymene*.

Under this rock is the coal formation of Ohio, the extent of which may be in some degree appreciated from the estimate made, namely, that the whole amount of coal in Jackson and Lawrence counties would be sufficient to form an entire stratum of 50 miles in length, 5 miles in width, and 9 feet in thickness, yielding about 9,000,000 of tons per square mile.

After this sketch of the geological structure of the Continent, so far as it is yet brought to light, we may be better prepared to understand the position occupied by the Thermal Waters, that have here and there been discovered.

The following appear to be the only ones exceeding the mean temperature of the climate, which have as yet been noticed:—

In the State of New York, 20 miles east of Albany, near the Shaker's village of Lebanon, occurs a spring possessing a constant temperature of 73° Fahr.

It emerges from the junction of talcose slate with an impure schistose limestone, containing, though scantily, organic remains, namely, five species of *Fucoides*, *Trilobites*, &c. There is a fault in the vicinity of the springs.

This thermal water has been frequently analyzed, but nothing of importance has been detected in its composition: it emits copiously bubbles of gas, which I examined on the spot, and found to contain no trace of carbonic acid, but to consist of nitrogen 89.4, oxygen 10.6.

In the same chain, as we proceed into the State of Vermont, we meet with one or two other slightly thermal waters, as at Williamstown in that State, and at Canaan at the foot of the Green Mountains.

I am disposed also to consider the carbonated waters of Ballston and Saratoga, which lie about 50 miles to the N. W. of Lebanon, as slightly thermal, for by reference to the Table, published by the Regents of New York University, it will be seen that Schenectady, the nearest post to these springs at which observations are recorded, and situated a little to the south of them, possesses a mean temperature of only 46.20 Fahr.

Now I found at Ballston, one of the springs to be 50.5°, and the other 49.5°; and at Saratoga, the new Congress Spring, 49.5°, Hamilton Spring, the same, and the old Congress Spring, 51°. At both these localities gas was given off, consisting chiefly of carbonic acid, but containing, after this had been removed in the usual way, a residuary portion of air, in which nitrogen and oxygen were both present, but with an excess of the former, as compared with the proportion existing in the atmosphere.

Springs evolving nitrogen gas are also found in the south-east corner of the township of Hoosick, in Rensselaer county in the state of Vermont. The gas is stated to be pure, and is evolved in great abundance, but the temperature of the water does

not appear to vary from that of the springs in the neighbourhood.

Of the same description are those of Chateaugay, in Franklin county, New York state. The gas issues abundantly, but the water does not rise above 40° Fahr., even in summer.

South of the Seneca falls, near the village of Cayuga, there gushes out from a fault in the limestone a copious spring of pure cold water, which is kept in a state of violent ebullition from the escape of nitrogen gas. This is the only instance of such a phenomenon in the midst of calcareous rocks, all others (says the author of the Report) known in the state of New York being near the junction of transition with primitive, or with metamorphic rocks.

The next group of thermal waters I shall notice is that which occurs in Virginia, and here I am indebted to professor William Rogers, for directing my attention to the geological structure of the country immediately bordering upon these springs, which I found to be strikingly corroborative of the views I had some time ago announced, with respect to there being a general connection between the occurrence of thermal waters, and of extensive disturbances or dislocations in the strata adjoining them^g.

^g For a full detail of the facts which have led me to this conclusion, I may refer to a memoir on Thermal Springs, in the Edinburgh New Philosophical Journal for 1831, and for a brief summary of the same, to my General Review of mineral and thermal waters, in the 6th Report of the British Association for the Advancement of Knowledge.

In the midst of the beautiful mountain region of Virginia, west of the Blue Ridge, but in that part of the chain which attains the highest elevation, and possesses the most picturesque character, is situated an assemblage of mineral waters, which, from their reputation as medicinal agents, as well as from the purity and coolness of the air which surrounds them, attract every summer, from all parts of the Union, and especially from the southern sections of it, crowds of persons, in search either of health or amusement^h.

Several of the most noted of these seem to possess the ordinary temperature of those in the neighbourhood, and to derive their efficacy from the sulphuretted hydrogen with which they are impregnated; such are the White, the Red, the Blue, and the Salt, Sulphur Springs.

The three former acquire their distinctive appellation from their colour, the difference in which is probably attributable to that of the conservae, that grow in them, and impart their respective hues to the water; the latter, designated as the Salt, owes its name to the presence in it of a larger proportion of common salt, than in the rest.

One, "the Sweet Spring," is strongly acidulous, and slightly thermal, but two, which appear to possess no remarkable mineral impregnation, are designated by the names of the Warm and the Hot Spring, from the more or less considerable elevation of temperature which belongs to them.

^h For an entertaining account of these springs, and of the journey to them, I may refer to a little guide book, published by my friend Mr. Philip Nicklin of Philadelphia, entitled, "Letters descriptive of the Virginia Springs by Peregrine Prolix, 1837."

The Warm Spring I found to possess a heat of 96° Fahr., the Hot Spring one of 102°, whereas the mean of the climate appears to be about 56°.

Both springs emitted bubbles of gas in considerable abundance, of which I collected samples.

That from the Warm Spring was found to contain, 6 per cent of carbonic acid, 94 per cent of nitrogen, and only 6 of oxygen; that from the Hot Spring varied a little according to the source from whence it was taken: the gas obtained from the ladies' bath consisting of, 11 per cent carbonic acid, 98 per cent nitrogen, 2 per cent oxygen; and that from the men's bath, 8 per cent carbonic acid, 96 nitrogen, and 4 oxygen. These proportions are computed on the assumption, that an expansion of 2 per cent takes place in nitrogen, after phosphorus has been heated and volatilized in the vessel that contains this gas.

Now both the above springs lie at a distance of about three miles one from the other, in a valley, the direction of which is nearly north and south, and it may be seen by reference to the section, which professor William Rogers has appended to his Geological Report of the State of Virginia, for 1836, that they are situated exactly at the anticlinal axis already alluded to.

And on examining the rocks on both sides of these springs, wherever the nature of the country allowed of my exploring them, I found every reason to place reliance on the correctness of his representation.

To the west of the Hot Spring, the more southern of the two thermal waters alluded to, the rocks become more and more inclined towards the west,

as they approach nearer to it, until at length in its immediate vicinity they assume an almost vertical position.

Immediately surrounding the spring, which issues from the bottom of the valley, are vertical beds of a blue fossiliferous limestone, called No. 2. by professor Rogers, being the lowest but one of the rocks incumbent on those of the Blue Ridge, which are included in his series.

A very compact sandstone, used as a freestone, succeeds, then beds of clay-slate again, and afterwards an highly ferruginous sandstone.

Up to this point, the rocks are inclined at so high an angle, that they may be regarded as vertical, and, in consequence of being so near the axis of the movement, they are often contorted and much disturbed.

Farther to the west, however, they are succeeded by strata, of sandstone, conglomerate, iron stone, and clay-slate, dipping at a gradual decreasing angle of inclination, and this continues to be the case until they become nearly horizontal.

On the east of this spring, the density of the forests is such, as rendered it impossible for me to obtain any knowledge of the mineral structure of the subjacent rocks, but this desideratum was supplied, by following the road running to the east of the Warm Spring, which, as I have already stated, lies in the same valley.

Here, as we ascend the so-called Warm Spring Mountain, we observe the very same rocks successively presented to us, which we had seen to the west of the "Hot Spring;" and these equally ver-

tical in the immediate neighbourhood of the spring, dipping in the reverse direction, and at a high angle, farther to the west, and at length subsiding to a moderate inclination at a still greater distance from the axis of elevation.

Such are the circumstances, which were originally communicated to me by professor Rogers, and which I had myself the satisfaction of verifying on the spot; and I am the more pleased in communicating them, as they supply another, and that a striking example, in addition to those I have adduced from other parts of the globe, of the connection of thermal springs with great physice' disturbances.

To these particulars I may add, that the Sweet Spring, the only other instance of a thermal water which this country exhibits, is situated, according to professor W. Rogers, in a locality, which evinces a considerable disturbance in the strata, as is represented in the section appended to his Report.

In Buncombe county, North Carolina, in the midst of a mountainous region, occurs a thermal water, possessing a temperature of 125° Fahr.

The rock from which it gushes, according to professor Vanuxem, is the calciferous sand-rock, the earliest member of the Silurian system, or that resting immediately on the primary.

The layers of the rock are very irregular, more or less vertical, and of a white colour, but at a little distance to the west, they present their blue colour, common to the rock where the lime is in excess, and their well defined parallel lines of separation dipping to the east.

The calciferous, with the primary rocks to the east, form a synclinal (anticlinal?) line, as is the case near the hot springs of Virginia^h.

To the west of the Alleghanies, in the state of Arkansas, at a distance of more than 200 miles west of the Mississippi, not far from the river Washita, is another group of thermal waters, which I took occasion to visit in the course of last spring.

They are very numerous, bursting out from the side of a steep acclivity, which they have in process of time incrustated over with a thick coating of stalagmitic matter.

It is remarkable, that the travertine, which the springs formerly deposited, is different in colour and appearance from what they produce at present; the former being dark looking, and containing a portion of iron, as well as of calcareous matter; the latter quite white, and consisting entirely of carbonate of lime.

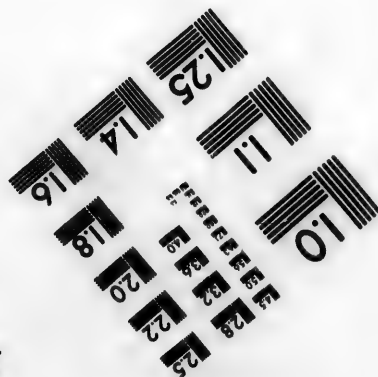
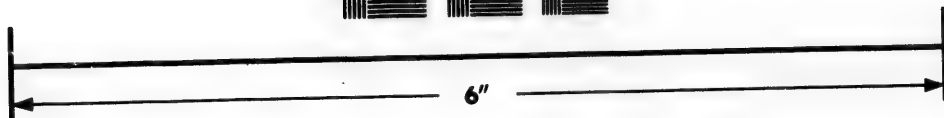
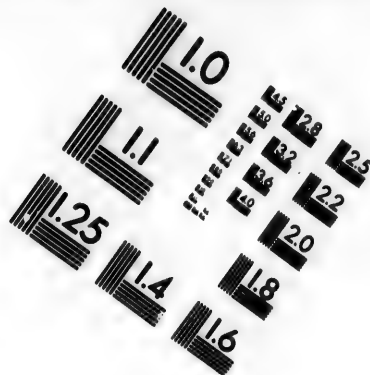
The springs vary considerably in temperature, the hottest being 148°, the coolest 118° Fahr., according to my observationsⁱ.

They contain very little mineral matter, a pint evaporated to dryness yielding no more than 1.8 gr. Of this, one half was carbonate of lime, and one fifth of a grain, silica. The rest was chiefly common salt, but there was a mere trace of sulphuric acid, when the water had been much concentrated. One of these springs deposited an ochreous precipitate,

^h Second Annual Report on the State of New York for 1838, p. 260.

ⁱ They are stated however in Silliman's Journal as rising as high as 154° or 156°.





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and gave indications of iron when tested. The remainder were entirely free from that ingredient.

Most of the springs emitted bubbles of gas, which, according to my experiments, consisted of carbonic acid 4 per cent, nitrogen 92.4, oxygen 7.6.

The rock, which forms the basis of the hill, from which the thermal springs of Washita issue, is a bluish fissile clay slate, dividing into nearly vertical laminae. Incumbent upon it, however, are beds of chert, quartz sandstone, and flinty slate, from the junction of which with the clay-slate the springs appear to gush out.

The prevailing rock, however, in the neighbourhood of the springs, so far as my observation extends, is quartz-rock, sometimes assuming the character of whetstone-slate, and in one locality, (situated within a few miles of the springs,) quarried for hones; but constituting a part of the same extensive formation, which I have represented myself as having followed, from Little Rock, in Arkansas, to St. Louis, in Missouri^k.

The chain is regarded by geographers as a branch

^k It may be useful to those travellers, who, perchance are meditating a similar excursion, and it at least is only just towards the settlers, on whose hospitality and good feeling I had to depend during the course of these rambles, for me to take this opportunity of testifying, what a perfect sense of security, and confidence of all needful protection, I shortly learnt to acquire, in whatever direction I thought proper to direct my footsteps through these wild and solitary districts.

No doubt there is often found in such countries, a recklessness of character—an indifference to the shedding of blood, which, if it arises in part from the difficulty of obtaining redress for injuries or affronts through the ordinary channels of justice, is at the same time fostered by the continual influx of the wilder

of the Ozark mountains, and is the first elevated land met with on proceeding westward from the

spirits from other States, who seek an asylum in regions not yet brought under the dominion of law.

But these very circumstances render it the more creditable to the older settlers of the country, to have established, by the force of opinion, throughout the wide tracts over which they are scattered, that pervading principle of honour and good faith, which not only exempts the stranger from risk to his person or his property, but guarantees to him, wherever he goes, all essential accommodations, without fear of extortion, or chance of insult.

In confirmation of these remarks, I have much satisfaction in quoting a passage from a letter, which I received a short time ago from a late distinguished member of the American bar and senate, whose warm-hearted hospitality and friendly attentions had procured for me, during a portion of my rambles, the rare privilege of surveying at my leisure an interesting and remote district, whilst in the full enjoyment of intellectual society, and of all the luxuries and comforts of civilisation.

"I think I see you," he says, "winding your way through the country between the Warm Springs of Arkansas and St. Louis. When I had health and strength, such travelling afforded me a great deal of pleasure.

"But you must have 'roughed' it, as they say here, with a vengeance, and at times felt severely the want, of what our habits make, and the world calls, comforts.

"Still there was a charm to me, in the solitude of our woods, and in the originality of character you so frequently meet with in these remote regions, which I cannot describe.

"I am glad you took the route, and I can confirm the truth of your remark, that the population of the distant settlements is greatly superior to the lower classes you meet with in our towns, and on our water-courses. The worst population of every country, I believe, is to be found on its sea-shores and navigable rivers. You may ride thousands of miles through the remotest and most thinly settled parts of a western country, with as complete a sense of security, as you would enjoy, in traversing the streets of London, under the eyes of half a dozen police officers—and the fact, which is undoubted, speaks, I think, volumes in favour of the people."

Mississippi, though its greatest height is probably not more than 500 or 600 feet above that river.

The only circumstance connected with this range of hills, which can throw any light upon the origin of the thermal waters that issue from it, is the breaking out at their foot, near New Madrid, of that tremendous earthquake, which, in 1812, caused the permanent submersion of a considerable tract of land near the Mississippi, now converted into an extensive swamp¹.

Such is the depth to which this tract has been submerged, that nothing but the summits of the trees, I am told, are seen standing above the surface of the stagnant morass.

A slightly thermal spring, which goes by the name of Mud Creek, exists in the same parallel as New Madrid, and at a distance of not many miles from the submerged tract in question.

Such are the principal particulars I have been able to bring together, either from personal observation, or from information supplied me by others, with respect to the thermal waters existing within the limits of the United States of America.

The rarity of such phenomena, when the extent of country is taken into account, as well as the unfrequent occurrence of acidulous or carbonated waters, might have been anticipated, from the unfrequency of earthquakes, the regularity of the rock formations, and the absence of trap rocks from so large a portion of the continent.

Nevertheless, the occurrence of a few such springs

¹ See Lyell's Principles of Geology, vol. 1. p. 408.

in the midst of the Alleghanies, and elsewhere, seems to shew, that volcanic operations are going on, in a covert and languid manner, underneath certain parts of that range.

To these operations, acting formerly with greater intensity, may perhaps be attributed, the uplifting of the chain itself, as well as the vertical and disturbed condition of the strata round about the anticlinal line; whereas, at present, the same forces only manifest their existence, by imparting a higher temperature to a few of the springs which burst out at this point, and possibly also, by causing the emission of those volumes, of sulphuretted hydrogen, and of carbonic acid, which impregnate others within a certain distance of this axis of elevation.